Pop-Machina

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Pop-Machina Circular Maker Academy

Deliverable 3.4 Building circular maker capacity through training

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http:/www.pop-machina.eu

Abstract

The Pop-Machina Academy (PMA) is a training programme co-designed to deliver the knowledge and making skills that future trainers in the field will need to enable actions for circular making and sustainability. Within the project's seven Pilot Cities, trainers will engage with their local communities in a collaborative effort for implementing new strategies and approaches towards circular ecosystems, with solutions mainly based on digital fabrication. The training programme has focused on stimulating practical know-how, following the principles of STEAM learning and 'learning by doing' methodologies. The programme is further enriched with thematic topics addressing business, circular and collaborative manufacturing, and learning within the consortium and beyond – especially by applying innovations in vocational teaching from within the Maker Movement. Despite the PMA being affected by the Coronavirus Crisis 2019 (COVID-19) pandemic, all planned activities were still achieved. Local regulations and mobility restrictions meant activities were moved online. The content reflected the changing social nature of the pandemic, successfully incorporating hands-on classes into a hybrid digital-physical learning environment for home-based learning. These methods aimed to encourage interactive, practice-based capacity building and peer-learning. The Academy was co-developed and deployed by M20 with selected local communities' Maker Champions (MCs) to support the pilot operations.

This report constitutes the Deliverable 3.4 "Building Circular Maker capacity through training", for Work Package 3 of the Pop-Machina project.

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Pop-Machina

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List of abbreviations

3D	Three dimensional
5 R's	Umbrella term for: Refuse, Reduce, Reuse, Repurpose, Recycle
CE	Circular Economy
CMS	Circular Maker Space
CMC	Circular Maker Community
CoP	Communities of Practice
D3.4	Deliverable 3.4 of the Pop-Machina project
DIY	Do It Yourself
IoT	Internet of Things
MC	Maker Champion
PAR	Participatory action research
PMA	Pop-Machina Circular Maker Academy (or simply "Academy")
FoF	Factories of the Future
KPI	Key Performance Indicators
LCMS	Liquid Circular Maker Space
OTF	Open Theses Fabrication
OKT	Open Knowledge Tool
SD	Sustainable Development
STEAM	Science Technology Engineering Arts Mathematics
SDG's	Sustainable Development Goals
WP4	Work Package 4 of the Pop-Machina project
WP5	Work Package 5 of the Pop-Machina project

Glossary

The glossary serves as a lexicon with the vocabulary used in this deliverable.

Active Learning Experiences

Active learning includes any learning experience in which the student actively thinks about the learning object, searching for meaning, and contrasting it with his or her previous knowledge (Prince, 2004). In the Pop Machina Academy we incorporate activities in which we "force" participants to think about what they are learning, especially on those key topics such as understanding the importance of materials, distributed design and maker technology. We do this by guiding the experiences in which we include explicit or demonstrative explanations and guiding the reasoning and reflection of the participants. Furthermore, the fact that we do it in a group and in a relaxed environment, facilitates the participants to share, counteract and discuss their ideas with the rest of the community, contributing to positive effects on the learning in a very significant way.

Challenge

The term challenge is used as an efficient and effective framework for learning and while solving real-local issues (Johnson, L. et al, 2009). The framework fuels collaboration to identify big ideas, ask thoughtful questions, and identify, investigate and solve challenges as a community of practice. It is a long term framework for the Circular Maker Space (CMS). The challenge is situated in the cities' local context and aims to support the city goals by rethinking how things are traditionally done and how these can address problems through the means of making in a collaborative and sustainable manner. The challenge is defined by the existing local limitations in the CMS (tools, machines, space dimensions and other available resources), the limitations of the driving team (number of people, diversity of profiles, skills and competences of each member), the city priorities and local problems. The framework fuels collaboration to identify big ideas, ask thoughtful questions, and identify, investigate and solve challenges as a community of practice. It also helps participants gain deep topic area knowledge and develop the skills necessary to thrive in an ever-changing world and accelerate their circular maker transition.

Co-Creation

Co-creation is a non-linear process that involves multiple stakeholders and actors in the ideation, implementation and assessments of products, services, policies and systems with the aim of improving their efficiency and effectiveness and the satisfaction of those who take part in the process[1]. The use of co-creation can be seen as a strategy to raise awareness and drive change, and a method to reconstruct the data from the bottom up for urban planning (e.g., waste management). This idea is based on "non-linear" and circular systems aiming to close off-limit material and resource loss and has the potential to minimise waste as highlighted by the Ellen Macarthur Foundation, thus creating opportunities for circular cities.

Co-Design

Design is used when problems are not well defined (complex or wicked problems), and solutions are unknown. In the co-design process, these problems are tackled in a collaborative manner similar to co-creation processes.

[1] Real, M. et al. (2019), "Co-Creation Journeys", Source: https://siscodeproject.eu/wp-content/uploads/2019/03/D3.1_Co-creation_Journeys.pdf

Collective Impact

Kania and Kramer (2011) define collective impact as a set of five conditions for collective action: common agenda, shared measurement systems, mutually reinforcing activities, continuous communication, and a backbone supporting organisation.

Community of Practice

Communities of Practice (CoP) are "groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (Lave, Wenger, 1998). Groups of people may come together locally or globally and over a period of time form a community based on their interest or shared concerns. These communities may be formed during the participation of an academic programme, or form naturally in makerspaces. The crucial aspect is that the "practitioners" in a CoP interact actively in their community, which may vary in forms such as sports or making practices.

Competence

The notion of competence entails a dynamic combination of the knowledge, skills and attitudes learners need to thrive and participate throughout life in a complex digital world (Lucas & Venckutė, 2020).

Cradle to Cradle

"*Cradle to Cradle*[2] *is a design framework for going beyond sustainability and designing for abundance in a Circular Economy*".

Design for remanufacturing

Designing quality products which can be disassembled and reused at the end of their lifecycle. This supports industrial symbiosis (See below).

Industrial Symbiosis

The process by which residual flows of an industry become raw materials for another. Dense urban areas found in cities often produce diverse material flows, allowing for industrial symbiosis to take place. The Maker Movement upskills the "maker" capacity of individuals, allowing them to participate in industrial symbiosis processes through working with the materials to design new products that feedback into the same system (aka, it becomes a 'circular' process).

Distributed Design

The Distributed Design model challenges the existing linear paradigm of the first industrial revolution and its associated phenomena; patenting, access to fabrication tools, supply chain distribution, value chains and technological development. It is a phenomenon that integrates design skills and the 'making' approach to enable the development of new entrepreneurial types of professional producers.

Learning Dimensions

Learning Dimensions is a framework of skills and competencies based on active learning experiences which are gained through making. In the context of the Pop-Machina Academy the Learning Dimensions are

[2] https://www.cradletocradle.com/

further elaborated with circular collaborative skills based on collective impact (see definition above). The Learning Dimension can be seen as a reflection of how a creative and collaborative environment, maker activities and facilitation enables such individual and collective skills development. The dimensions do not develop linearly or hierarchically. Multiple dimensions become intertwined during the "challenge". Many of the Learning Dimensions only became evident over time, through triangulation of the videos of students' tinkering, excerpts from student journals, and interviews with students and/or their teachers. The Learning Dimensions are not accidental, they are created through careful attention to the nature of the tinkering/making activities, environment, and pedagogy. The purpose of this framework is ultimately to guide the design and facilitation of tinkering activities and environments that can produce these learning outcomes. The framework can also be used as a reflective tool to formatively assess students' learning.

Lifelong Learning

Lifelong Learning captures the seemingly simple idea that in order to flourish in the contemporary world humans need to learn significantly across the different phases of their lifespan (Hager, 2012). Learning does not only happen in educational systems but at any time in life at any place through experiences. Learning is an ongoing process based on the attitude and pursuit of an entity being curious to learn. This may come in many forms and may change over the duration of time, however the constant is the motivation to gain knowledge.

Liquid Circular Maker Space

On a basic level, a liquid circular maker space (LCMS) serves as a site where circular and equitable solutions to complex problems can develop, mature and scale. The space, its community makers and their innovations strive to re-define how society has operated for generations since the industrial revolution by actively prioritising the creation of positive social and environmental impacts. To do so, LCMSs collect, learn from and create global knowledge that can be adapted for local solutions. We define them as "liquid" because of their ability to change and mutate easily both physically and holistically depending on the profile of the makers and the areas of interest of the communities that lead them at any given time. Doing so whilst maintaining their positive impact as drivers of transition to a more circular, green and sustainable local environment. The term "liquid" is applied to educational environments and is derived from Bauman's concept of 'liquid modernity' (2000).

Local collaborative production

Instead of having to travel for thousands of kilometres and adding much unnecessary CO^2 to our atmosphere, products are produced km0 in a local "factory" or "Maker Space" next door, using waste harvested from the neighbourhood (e.g., re-use, up-cycling). This can relate to urban renewal in a compact city (Jacobs, 1961, Dantzig & Saaty, 1973) as a concept, which means good planning to achieve a more compact overall urban form. Dense urban areas hold the potential for local production, there is enough people, resources, knowledge, and capital to make it happen. "Makers" in the Maker Movement have enough skills and knowledge to come up with innovative solutions to use waste as a resource.

Makerspaces

The definition used for the Pop Machina projects according to Deliverable 2.1 (Meta, J. 2020) is: "*a makerspace is a place, which can host workshops, and is open to the public. A makerspace is a community place where tools are present. Makerspaces usually combine manufacturing tools, community and educational means to enable community members to design,*

prototype and create manufactured objects that would not be possible for someone working alone. These spaces can be created both around individuals wishing to share places and machines and within an association, whether for profit or not, schools, universities, libraries, etc."

Maker Champions

The Maker Champions (MCs) are the volunteers and selected people who participated in the PMA. Following the course, the trainers approach the MCs after their successful graduation from the Academy. The trainers will operate locally in the CMS and become community leaders.

Maker Clubs

Maker Clubs are learning environments designed to develop the skills and competences related to code, make, circularity, materials and grow topics. Hands-on practical activities to promote peer to peer learning and community building may emerge in maker spaces and are on a basic level a group of people sharing the same interests. In a practical sense, this means the groups of people from around one topic such as electronics or recycling. Ideally, these clubs would be kept locally to collaborate on a physical level and share knowledge globally but they can also be complemented virtually in synchronous or asynchronous online communication environments. Some PMA sessions and the specific channels created by MCs on the Slack platform are examples of this.

Skill

Skill is the expertise or the ability to do something well. The Encyclopedia of the Sciences of Learning suggests that a skill is "an overlearned behavioural routine resulting from practice" (2012). Skills are increasingly divided into categories such as basic or higher; or as 'behavioural and social', 'technical' or 'creativity and critical thinking'; or as 'academic' or 'vocational'. Basics of coding, 2D and 3D design, use of electronics circuits for data collection, digital fabrication for prototyping artefacts, moulding and casting with biomaterials are some of the technical skills covered during the PMA.

Soft Skill

Skills which are largely non-cognitive and social such as creativity, problem-solving, critical thinking are held up as being different from 'hard' skills such as maths or languages or technical skills to do with a specific vocation. These are frequently used by employers as a near synonym for competencies or transversal skills, often with the implication that such skills are transferable. Problem solving, critical thinking, creativity, social and emotional engagement are some of the soft skills developed by the PMA participants.

STEAM

STEAM is an educational and innovation framework bringing science, technology, engineering and mathematics together with the arts/other disciplines (STEM + Art=STEAM or S-TEAM). The STEAM framework also aims to bring together all types of learners with the goal of being more engaging, creative and naturally successful for all members of any educational system, formal or informal. We need to add "Art" to turn STEM into STEAM.

Artists and designers make information more understandable, products more desirable, and new inventions possible through the project-based inquiry that has long been practised in the art studio (Maeda, 2013). By

investing in art/science collaborations in research and education we can keep our society at the forefront of innovation, ensuring our sustained global leadership and cultural prosperity in the 21st century.

The Circular Maker Academy

The Pop-Machina Academy may also be called the Circular Maker Academy. The Circular Maker Academy is an iteration of learning experiences and academic programmes such as Fab Academy or Fabricademy. It includes principles of the Circular Economy for a more holistic approach towards existing making practices.

The Circular Maker Movement

The emergent idea of a Circular Maker Movement is the notion of circularity applied within the Maker Movement. The Circular Maker Academy works on shared active learning experiences and academic programmes which aims to enable the transition towards more Circular Maker Spaces. It challenges the existing Maker Movement to think further and apply methodologies which may help society pivot towards circularity, in a more holistic way.

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1. WHAT: The Pop-Machina Academy

1.1 Introduction

The Pop Machina Academy (PMA) is a circular making and innovation training programme that provides the local Champions of the seven Pilot Cities with the training and guidance they need to successfully realize their projects. The first part of the PMA took place in 2020 and began with an immersive training programme for the trainers who will become the local "Champions" for circular making and innovation in each Pop-Machina Pilot City. The Academy combines online and physical activities. The local Maker Champions (MC) of each Pilot City took part in an immersive training programme (June - October 2020) online and in webinars. Secondly, all the information, toolkits and guides are compiled in the PMA repository. The repository will be available throughout and after the completion of the Pop-Machina Project.

1.2 Scope and objectives

At the heart of this training programme report (D3.4 Pop-Machina training programme), the Academy, as a concept and a method, brings together a range of learning approaches with the goal of supporting the deployment of the Pop-Machina project as a whole. The specific objectives are structured in four main aims:

1. First, the Academy has been aligned with the Fab Academy - an established initiative active the past 10 years; drawing and sharing experience and content. Basic digital fabrication knowledge is added and combined with circular economy principles, such as materials flows, product life-cycle, design for disassembly, and business models based on sustainability principles. The maker capacity through training programmes focuses on mission-driven innovation principles, fostering the entrepreneurial spirit within the programme. In order to learn from best practices, the process of building the maker capacity within the Pop Machina Pilot Cities connects with already existing Fab Labs and makerspace communities and vocational training programmes.
2. Secondly, the Academy is promoted as a framework that must be re-contextualized according to the values and specific history of each city that adopts it, and assigns the local Champion (autonomous local trainer) the role of active agent of the framework, instead of being a simple transmitter.
3. Thirdly, the timeline for the co-creation process and implementation of the strategy consists of the pre-activities, 20 instructional capacity building workshops, guided challenge co-creation and autonomous challenge design. In the autonomous stage of the project the local Champions will be able to use the available resources to run the CMS and provide activities to address their local challenges.
4. Finally, in accordance with the EU Circular Economy Action Plan[3], the Academy aims to fill in the gap of Circular Economy innovation actions by testing in the Pilot Cities. This testing will take the form of the promotion and development of makerspaces for a more re-distributed, decentralised and local manufacturing, whilst linking with policy level in cities.

[3] European Commission. (2020). EU Circular Economy Action Plan. Retrieved from https://ec.europa.eu/environment/circular-economy/index_en.htm [last accessed 15/10/2020].

1.3 Relevant linkages to other WP's and deliverables

The broader envisioned impact of Pop-Machina is to demonstrate the potential to reduce the consumption of primary materials through the development of new circular products at a local scale, triggering a pro sustainability mentality shift and a transition from consumer to maker-prosumer (for a wider assessment, see the Pop-Machina Deliverables 2.1 and 2.4). The Academy strategy includes the collaboratively acquired work from the Pop-Machina programme partners. The collaboration between the partners assures the development of an elaborate and comprehensive strategy which can be reproduced and distributed. The strategy is a general overview or framework on how the Academy is being implemented and with the goal of giving guidance for each Pilot City in the facilitation process. The key linkage between D3.4 and the other Work Packages has advanced in congruence with the WP5 tasks, supporting the pilot deployment through capacity building. Guiding not only the MCs but also the municipalities and city teams. This deliverable provides extensive documentation on the training programme, including its materials, modules, and curriculum. The Academy content is available to be shared on the Pop-Machina's social collaboration platform. Through the PMA we provide the Academy programme, which hosts course content and designs open for further iterations, such as the Open Knowledge Tool (WP4). The Academy Programme also contains the theory and principles of the Liquid Circular Maker Space (LCMS), including the manifesto, provisional inventory and the meaning of being a Circular Maker Champion (CMC).

During the PMA we have trained the trainers, therefore providing qualified MCs which will operate in the CMS in the seven respective Pilot Cities. Which means that the PMA (Deliverable 3.4) is strongly linked to the pilot deployment (Work Package 5). We encouraged the MCs to be in contact with their city teams to understand who and how they can collaborate and support each other for a successful pilot deployment. Our team has had open communication channels with the other task leaders and Work Packages leaders to assure that workflows are aligned. We had two collaborative sessions with WP5, and have tried to incorporate relevant work from other deliverables of the Pop Machina partners. We have tried, to the best of our capabilities, to give a holistic overview of what it means to work in a CMS to our MCs. Nonetheless, it is not in the scope of our work to design the CMS nor the pilot deployment. What we have offered during the PMA is support to our partners, city teams and MCs in terms of CMS inventory, layout and design when needed. The city priorities (WP5) are linked to the CMS goals. The city priorities, CMS capabilities and genuine local problems or issues give the context for the challenge set-up in which the MCs engage citizens to become part of a CMC. In detail we have collaboratively matched the city priorities and Pop-Machina goals with chosen workshops from the 21 Workshop repository. Additionally the city teams were able to add missing workshops which they have identified as useful for implementation. At the same time they made a rough estimation as to whether these activities should be conducted online or offline, or both and what the target group should be. The task leaders from WP5 will use this information for the city deployment and we will use these insights to prepare complimentary materials for the 21 Workshops. (For more information, see the annex 2).

1.4 Key Performance Indicators (KPI's) addressed in D3.4

This section specifies the KPIs addressed in D3.4. We have recapitulated the contributions achieved by the deliverable in relation to both KPI-19 and KPI-22. The following two subsections show how and to what extent the deliverable contributes to each KPIs, separately.

KPI-19. Community training method and material for co-designing circular monitoring systems: (1-2 per pilot)
As specified by the Grant Agreement, this KPI also concerns T5.2; T7.1; T7.2; T7.3; This KPI will be partially completed by T3.4. Although the Pilot Cities are responsible for compliance with this KPI, this task (T3.4) will contribute to its achievement in two ways. First, the creation of a PMA Framework with open education content, tools and resources for capacity building and methodologies for facilitation and training. And second, the Immersive Training Programme for local MCs (at least 1-3 per each pilot city) embedded in the PMA.

KPI-22. Makers as beneficiaries of creativity and entrepreneurship training activities (50 per pilot)
As specified by the Grant Agreement, this KPI also concerns T3.2; T3.3; T5.2; This KPI will be partially completed by T3.4. Although the pilot cities are responsible for compliance with this KPI, this task (T3.4) will contribute to its achievement in three ways aligned with T5.1. First, the Immersive Training Programme for local MCs (at least 1-2 per each pilot city) embedded in the PMA. Second, the series of 20 workshops designed for community engagement and the development of maker skills including creativity and entrepreneurship. Finally, the PMA itself has open content, resources, references and methodologies for replication and adaptation for the local context. The deliverable of this task contemplates an online repository for the PMA.

1.5 How to read this report?

The sections are divided as follows: what is the Pop-Machina Academy (PMA); the background of who is behind its constitution; why it stands for the emergence of Circular Maker Spaces (CMSs) and the Liquid Circular Maker Manifesto; how the methodology was established, the strategy and approach used alongside the PMA Curricula, the learning dimensions, making and facilitation skills suggested via the the "challenges" set up for the PMA; an outline and structure of the PMA; where and when it took place, in practice (in annexes). Each session guides the reader to assess why we approach the Academy the way we do, who influences the work conducted, when the Academy took place and what was learned.

2. Methodologies for supporting circular maker communities in urban and peri-urban spaces

As a community-based initiative, the Pop-Machina Circular Maker Academy (PMA, or simply "Academy") is designed to explore learning for creating and maintaining Circular Maker Spaces (CMS). It is a training method based on critical research methodology, in which "community" is placed at the centre of the analysis.

2.1 Background

In the twenty-first century, we got really good at 'producing' experts at scale (nano to earth level). However, what we continuously fail at, is connecting experts and intelligence up and down the entire ecosystem so that we can have a holistic understanding of the current state of the system and where we need to intervene to have the best impact as fast as possible. The challenge of this century is how to connect different scales and expertise for transformative change across the whole system, individuals, and urban metabolism. In recent years the realisation that society is facing major issues due to climate change has become more prominent. The emergence of Industry 4.0 and the global shift away from fossil fuels; stress in natural ecosystems; climate change and over-consumption has raised questions about the nature of and culture around the products we buy, use, and dispose of – as well as the support systems in which they circulate globally. The widespread use of fossil fuels, for instance, causes several challenges. The UN states that carbon-based energy generation has a large ecological footprint, not only due to rising greenhouse gas emissions and pollution caused by burning fuels, but also because of extraction techniques that contaminate the environment, and frequent production or delivery accidents. Furthermore, because of the current mono-dependency on fossil fuels, supply drops or price hikes can easily disrupt economies. Fossil fuels are also all too often a source of regional conflicts and are misused as a means of political pressure. Besides, fossil fuel resources are not infinite, and their depletion is a near reality. In conclusion, choosing materials, tools, and methods with little regard to their systemic or long-term effects, creates a set of new, interconnected, and more complex problems.

Sustainability

The understanding that sustainability comprises three dimensions, environmental (healthy environment), social (justice) and economic (in relation to the design of a circular economy) was acknowledged. As an umbrella concept, the 'Brundtland' (WCED, 1987) understanding of sustainable development[4] (SD) offered some guidance; therefore, it has an intergenerational justice connotation. This SD definition is adequate in some ways but does not give guidance as to the design of such a society. To be functional, the set of principles for the objective must be appropriate, adaptive, and sufficient. Moreover, SD issues require fundamental change, new approaches, new understanding, solution based design and interventions to solve a range of problems related especially to its social and environmental dimensions. Yet societies keep trying to solve problems with the same 'resources' that caused them. A 'practice of change' (Ito, 2018) would require a paradigm shift to achieve positive outcomes, and an architecture of layers of interoperability to unbundle

[4] Sustainable Development (SD) being a "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987).

complex, inflexible, and monolithic systems and increase competition, cooperation, generativity, and flexibility. Sustainability approaches and their trajectories are progressions and not exclusive of one another as all practice levels are necessary to achieve this change towards regeneration (Reed, 2007) "design needs to be in response to the local biosphere and the specific place that the architecture is generated for" (Littman, 2009). Being both a regenerative system and a closed loop life cycle, every being or element is interdependent. Therefore, regenerative design needs to be a restorative conscious design development benefiting the ecology and the built environment (Lyle, 1976). Fostering social cohesion is also a matter of having socio-ecological cohesion, whereby the urbanisation of nature and its socio-environmentally enabling and disabling conditions are key processes. The social exclusion itself would represent a problem for sense-making, legitimacy, and efficacy for urban planning. Therefore, international agencies such as the UNDP have acted (since 1990) as a basis to redirect the orientation of development policy from economic goals to human wellbeing, enhancing people-centred social policies and positive freedom (Gasper, 2004). The Sustainable Development Goals (SDGs) aim to enhance a post-2015 global emerging consensus for 'equality of opportunities' and the fight for those who live in extreme deprivation to access citizenship (Ravallion, 2010). Albeit 'development' patterns were either modified by flaws in the private investment process, by the policies of governments, and the effects of wars (Rostow, 1960:4-16). Following the debt crisis of the late 1970s, Structural Adjustment programmes were the vanguard of a new development paradigm based on liberalisation and economic efficiency, these policies had significant impacts on the scope of SD. Measuring value financially has created a competitive market-based system that has provided many societal benefits but has produced complex problems not solvable through competitive market-based solutions (Ito, 2018). When looking at SD in urban areas, cities face a paradox in the challenge of citizens and communities driving the need for SD whilst economic policies sometimes restrict the full potential of a paradigm shift in behaviours. This can hinder progress, in which a need to 'destabilize stable meanings' (Sassen, 2014) would enable a shift in economic perspectives to allow SD to happen.

Making Circularity

Transforming cities from outdated manufacturing flows to productive cities for a resilient future plays a key role in addressing circularity issues (Dassen & Haajer, 2014). From a global level, to countries, regions, cities, neighbourhoods and citizens. Individuals' ability to obtain information and resources through social networks and spaces within cities plays an important role in encountering climate action practices (Smith et al., 2012). The challenges, therefore, need to be broken down into simple actions which can be realised by individuals or groups. The shared narrative and purpose are kept to ensure we are working together towards a common vision (Potjer, 2019). Whilst these are global problems, a range of spatial issues have to be addressed locally. This mindset brings light to complex ecosystems of co-developing solutions for positive impact on the everyday reality of citizens. Likewise, initiatives that have their origin at the individual and local community level and that emerge in a bottom-up manner with circulation of knowledge will also benefit from this point of view. (Capdevila & Zarlenga, 2015). Makerspaces' users hold the potential to empower local communities to participate in processes of 'fabricating resilience' and 'sustainability', by experimenting with 'social learning' and new forms of collaborative production. The concept fortifies communities' culture and behaviours towards positive societal impact. If this practice of 'making' spreads, it could become part of a shift towards more distributed production with less environmental impact. Makers create ideologies and design their 'reality' to support a counter-position. (Kohtala, 2016).

The European Commission stated that eco design rules are necessary considerations for implementing the Circular Economy Action Plan. Therefore reparability, durability, upgradability, or recyclability should be at the forefront of all considerations. The researchers analysed existing eco-design principles, categorising guidelines into five groups:

1. Extending lifespan and durability of products through adaptability, upgradeability, and 'timelessness', using modular design and standardised components,
2. Disassembling, enabling easy access to parts, encouraging their re-use,
3. Product re-use, promoting easy maintenance and cleaning of products and their parts,
4. Component re-use of standardised parts with minimal variation in product design,
5. Material recycling, with labels that enable materials to be easily identified, separated, and recycled, avoiding complex mixtures of materials.

Further, the New Circular Economy Action Plan also puts forward a series of actions to minimise EU exports of waste and tackle illegal shipments.

Table 01 'Principles for making in a collaborative circular economy'(Source: PMD2.2 Pavlopoulou, Y., 2020)

3. WHO: Maker Movement

The concise definition of the maker movement within the framework of Pop-Machina project is as follows: "*the maker movement consists of a variety of stakeholders organising initiatives that are part of the supply chain of "making".The initiatives often aim at tackling social and environmental issues, they are often grassroots, and led by local communities"* (for more information and related glossary, see Pop-Machina D2.1). The particular stakeholder groups, projects and spaces presented in this section (miscellaneous) are relevant for the project's deliverable accomplishment.

3.1 The Makerspace

A makerspace is a community-led open space where individuals share resources and meet on a regular basis to collaboratively engage in creative commons-oriented projects, usually utilising open source software and hardware technologies. They produce their own solutions in co-working places which may go by various names like microfactories, hackerspaces, fab labs, urban labs, living labs, media labs and others (Gandini, 2015). Some of these terms will be employed at several stages, but the term "makerspace" is used as an umbrella for all of them. Traditionally, makerspaces (or "shared machine shops") combine manufacturing tools, community and education means to enable people to design, prototype and create manufactured objects. There are a variety of different types of these spaces. Hackerspaces, Repair Cafes, Fab Labs are only a few examples, each one of them can be distinguished by their focus of work, however, they do share many things in common. All of these spaces encourage citizen participation, participatory making practices and alternative production (Maxigas and Troxler, 2014). Often these spaces are connected to cultural institutions such as universities, museums, cultural centres as well as big enterprises and entrepreneurial projects such as start-up accelerators, co-working spaces (Álvaro Sánchez, 2018). They may come in different shapes and sizes and encourage hybrid forms of social interactions and physical production. Needless to say, that they also come with their limitations. Even though empowerment of people, openness and accessibility, are often implicit, the notion of such has to become explicit and actively fostered. Addressing these collective issues and addressing them collectively is crucial to supporting and guaranteeing the spread of digital literacy,

capacity and community building (Álvaro Sánchez, 2018). Generating networks of spaces for collaborative social innovation and production.

3.2 The Fab Lab Network

The Fab Lab Network is an open, creative community of fabricators, artists, scientists, engineers, educators, students, amateurs, professionals, of all ages. There are over 1800 Fab Labs in 100 plus countries. Fab Labs are a unique type of makerspace.

3.2 Fab Lab Barcelona

Fab Lab Barcelona is an innovation centre rethinking the way we live, work and play in cities. The first Fab Lab founded in the European Union, in 2007, it is a benchmark for the powerful Fab Lab Network. Fab Lab Barcelona produces world-leading research and innovation based around the digital fabrication laboratory which is located at our heart. We are situated inside the Institute for Advanced Architecture of Catalonia (IAAC) in the 22@ District, Poblenou, Barcelona. The building, which was a former ceramics factory, is a laboratory for ideas. We use our digital fabrication facilities to prototype, fabricate and test these ideas in the real world as research, education and innovation. Including 18 European Research projects since 2014. We are a world leader of programmes for the future of education. In 2018, The Master of Design for Emergent Futures was launched by IAAC and ELISAVA, co-directed and curated by Fab Lab Barcelona. As part of the transition into Industry 4.0 and leading the Fab City initiative, Fab Lab Barcelona focuses on the human-scale and the everyday experience; identifying opportunities in rising trends across seven strategic areas of expertise.

3.3 Fab Academy

Fab Academy is a Digital Fabrication programme directed by Neil Gershenfeld of MIT's Center For Bits and Atoms and based on MIT's rapid prototyping course: How to Make (Almost) Anything. Fab Academy focuses on personal fabrication – prototyping your ideas into products. It is a global distributed education programme led by Fab Foundation, MIT's Center for Bits and Atoms and Fab Lab Barcelona. The global programme has taken place in 65 different locations. Fab Academy is an intensive five-month programme that teaches students to envision, design and prototype projects using digital fabrication tools and machines. It is a multi-disciplinary and hands-on learning experience that empowers students to learn-by-doing and inspires them to make locally to become active participants in sustainable cities and communities. Fab Academy in Barcelona is led by the Future Learning Unit (FLU), a savvy team designing creative and active learning experiences with digital fabrication tools. FLU's mindset is at the heart of PMA. Building on top of over ten years, in which Fab Lab Barcelona has become a global benchmark for the Fab Academy experience. Students come from every continent to study in Barcelona with the Future Learning Unit and experts from Fab Lab Barcelona. Future of Education specialist and Fab Academy Barcelona alumni Santi Fuentemilla leads the hands-on instruction in the lab, supported by multidisciplinary experts in digital fabrication, robotics, machine learning, coding and materials. Students in Barcelona study in a professional lab environment. In addition, the course is delivered in collaboration with students from the IAAC Master of Design for Emergent Futures which provides an opportunity to expand professional and personal

experiences. Alumni of the programme have used their future-skills to build leading roles in the global Fab Lab network, established their own design studios and become entrepreneurs in the innovation and social design fields.

3.4 Fab City Global Initiative

Fab City Global Initiative is a collective of civic leaders, makers, urbanists and innovators working on shifting the industrial urban paradigm to one that better supports life on Earth. A global collaboration with a distributed network of cities prototypes local approaches to meet the challenge of producing everything the city consumes by 2054 (Diez, 2018).

3.5 The Maker Champions

The PMA is intended for the three local Champions from each of the seven Pilot Cities, Leuven, Thessaloniki, Santander, Istanbul, Piraeus, Kaunas, Venlo. The content which is located in the local training section can then be used by the local Champions to co-create Circular Maker Spaces (CMS), engage citizens and makers to become part of a circular maker community. We are, wherever possible, taking into account real-time demand from makers and potential new makers from diverse backgrounds. Therefore we are aiming to co-create a circular making workshop, including practical methodologies based on scientific research, with experience and knowledge from the network and consortium for learning and enhancing skills. (Are you curious about "what makes the best profile of a Maker Champion?" You may want to check our stars on the seventh session.)

4. WHY: The emergence of Circular Maker Spaces

This section argues for the importance of acquiring the skills and knowledge delivered by the PMA. It also claims the training programme holds the potential to build capacity on Maker Champions interested in contributing to advance a transition from traditional makerspaces to Circular Maker Spaces (CMS). The argumentation starts with a short historical retrospective and concludes with the creation of the first version of the Liquid Circular Maker Space Manifesto, which is presented in the final section of this document.

Crafts and making has gone through a transition over the history of time. From the ancient times of making a single object to today's mass producing almost anything. Already, in the early years of humanity, people made things. The main purpose of many of these things were often to serve specific actions; such as the making of bow and arrow, or the making of vessels to contain liquids or food. All the objects were objects of necessity and purpose. However, things were not only being made for the sake of making things. Indeed, a vase first and foremost is serving a functionality, but beyond that it is telling a story. Making with and through the hands of a craftsperson is telling a story in the material phenomena itself. With every finger movement the shape of the vase is distinguished, with every paint stroke there is a character inherently connecting the maker with the material through the making. The artists of Greece, Egypt, Morocco, Italy and all over the world tell their local stories through objects being made. Hence the object made is not only for the purpose itself but a connection to place. Through travelling over land and sea, goods were able to be taken beyond their countries

boundaries. Objects from "somewhere else" have become precious. People in the west have decorated their homes with specialities of the east and vice versa. The "otherness" shown in the handcrafted objects, have become symbols of prestige. Historically, places for arts and crafts were the first physical established spaces of making. The carpenter, blacksmith and many more craftspeople were important actors in the evolution, building and sustaining of cities. These spaces were, and still are, spaces which not only consist of physical material where products are made but are also spaces of expertise and knowledge. The craftspeople have shared their knowledge over generations, fostering and building capacity within people. The workshop, for many centuries, has been a place in which craftspeople come together to develop skills and make things. It has been a space in which embodied knowledge can be formed by linking between the physical and the social (Sennett 2012).

With the industrial revolution the craftsperson has faced challenges of survival. Making a living wage has become difficult for many. The demand of society for a greater number of products at a quicker rate has dominated the narrative on how we produce things (Curtis, 2002). Large-scale production spaces with assembly lines have created new jobs and made others obsolete. The craftsperson was put into a difficult position and throughout history this can be seen as a challenge. However, makerspaces, which have emerged as spaces of manufacturing and creation, are a reason for hope and offer potential to reverse the fortunes of the craftsperson. Many years of experimentation, knowledge generation and adaptation made it possible to have a global network of makerspaces. These makerspaces come in all different sizes and vary in their focus of work and are thus now facing their limitations in terms of versatility. The capacity of prototyping, making and distributing manufacturing based on digital fabrication methods have reached a state which allows further exploration to amplify the impact of makerspaces. In this sense this evolution can be seen as iterations of how we make. Coming from local crafts, to mass production, from a Product In Trash Out (PITO) towards a Data In Data Out (DITO) model. CMS are the next iteration, which are taking local and global factors into account. These factors include local material flows and challenges.

In conclusion, we claim that the CMS is an evolution of makerspaces towards circularity. The PMA is a driver for capacity building of CMs that will embrace the attitude needed for this transition towards CMS's. This transition is a necessity to adapt to the current challenges faced by humanity with particular reference to climate change and climate emergency[5]. People are intrinsically interconnected with their environment therefore everything within this environmental network is defined by their relation[6] towards each other. These networks are not static, they are liquid; these two assumptions combined are not paradoxical. Thus, these networks are constantly changing with inherited entities and influenced by endogenous and exogenous factors. The idea of the Liquid Circular Maker Space (LCMS) has emerged before and was consolidated during the planning of the PMA. In the times of a global pandemic, this idea has flourished. In a year in which people are bound to their home the notion of space is being questioned and is yet again a challenge which physical CMS are facing. The question is: beyond the physical space, what is a LCMS? The LCMS is a network of nodes, it is more than a space, it is about people. To work with people means also to be able to

[5] Climate change and environmental degradation are an existential threat to Europe and the world: The European New Green Deal, available at: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en accessed in January 2021.

[6] The idea of "relational" means navigating through unequal relations of power of the political economy of knowledge production. For this action research and training programme, the emphasis on diverse skill sets needed in research collaborations and establishing mechanisms to collect information and produce outputs collaboratively.

work with diverse communities and foster equality. For this (and based on a request from our Istanbul MCs) we have created a document which is available for all MCs. The document consists of references from research and academia for working with diverse communities and can be found in the annex. The Liquid Circular Maker Space Manifesto is a concept and a living document which is being updated over a duration of time, this concept thrives by being challenged, revised and adapted. Through the interaction with projects, people and places new relations and meaningful possibilities can be established which allows the Manifesto to evolve, just as liquid as the idea of the LCMS itself.

5. HOW: Methodology

The Pop-Machina Academy (PMA) methodology is a meta-analysis triangulation based on multi methods and participatory action research (PAR) in pedagogy. We gather quantitative and qualitative data for continuous and retrospective evaluation before, during and after the programme, acknowledging that each method has its strengths, weaknesses and limitations. We have examined the Academy closely from the point of view of a researcher, maker, educator and participant of the Academy itself. We created the immersive training programme based on the knowledge and expertise of Fab Lab Barcelona, Fabacademy and the Future Learning Unit (FLU) expertise combined with a range of topics related to emerging futures. How each of these influenced the curation of the Academy will be explained in more detail later in this section. PAR is considered a qualitative research methodology which highlights "the notion of action as a legitimate mode of knowing, thereby taking the realm of knowledge into the field of practice" (Tandon, 1996:21). It also strives for "a more even distribution of power-knowledge among its constituents, a healthier balance between institutions and civil society and more grassroots creativity and initiative" (Fals-Borda & Rahman, 1991:6). PAR can be regarded as an appropriate approach for the design of technological infrastructure, in which communities are the "subject" of the research and techno-social design rather than the "objects" of it. Hence, this approach is relevant to knowledge sharing as well as people-centeredness. Bottom-up approaches, like PAR, may prove more effective for promoting solutions and good practices within communities. Participatory methodologies, which assimilate the specific needs of the population of interest, are the most suitable tool for developing effective practices (Fors and Moreno, 2002; Fraser et al., 2006).

5.1 Design Approach

Design research methodology (Blessing & Chakrabarti, 2009) was implemented for conceiving the Academy strategy and approach in practice within the Pilot Cities. The case studies have helped to understand the dynamics of the social structure and can support understanding how learning in the context of this project could ultimately thrive in a complex world. It explores how and why simplicity tames complexity in life, communities, and nature, as the "strategy" is a structured chaos. As case studies for monitoring this action research, the seven Pilot Cities and their various organisations and communities were engaged in the work in progress for proper validation and consultation. As units of observation, this research target falls between the micro level focus on individuals (namely "Champions"), and higher-level observations of larger ecosystems (e.g. Fab Lab and Fab Cities networks) in order to leverage circular ecosystem vision, such as the 'layers of networks' for circular urban models. Ultimately, action research implies that the research conducted is

collaborative, hence our research is influenced by and created with whom we are collaborating with. In constructivism epistemology, a concept for a potential case study would emerge from trying to understand the dynamics in which a "subject of analysis" and their social constructs functions. This integrative analysis contributes to the plural theory of building and learning, considering knowledge as both a co-product and a source of empowerment. The role of the action researchers (trainers) has explored ways to raise awareness and prototype the alpha version of the training programme as a proxy for future studies and practice within the maker movement. Therefore, the Academy as an intervention might be seen as a method in itself. We hope that through this approach the multiple layers and the complexity of the Academy will lead to a more complete understanding in future iterations. Whilst prototyping this new immersive training format, completely online and distributed, we continuously adapted for iterative learning for both the facilitators and the participants.

This action-based research is contextualised in a wider analytical framework of the new urban model of a Fab City. The model proposes a shift in the urban paradigm from 'PITO' (product-in, trash-out) to 'DIDO' (data-in, data-out), focusing on the movement of data, use of local material supply chains and digital fabrication as an alternative to the movement of materials and goods from production to consumer. In the case of design, this not only provides consumers with more control over their final products by allowing them a voice in the production process, but can also provide designers access to collaborators and tools across global infrastructure networks (Diez, 2018).

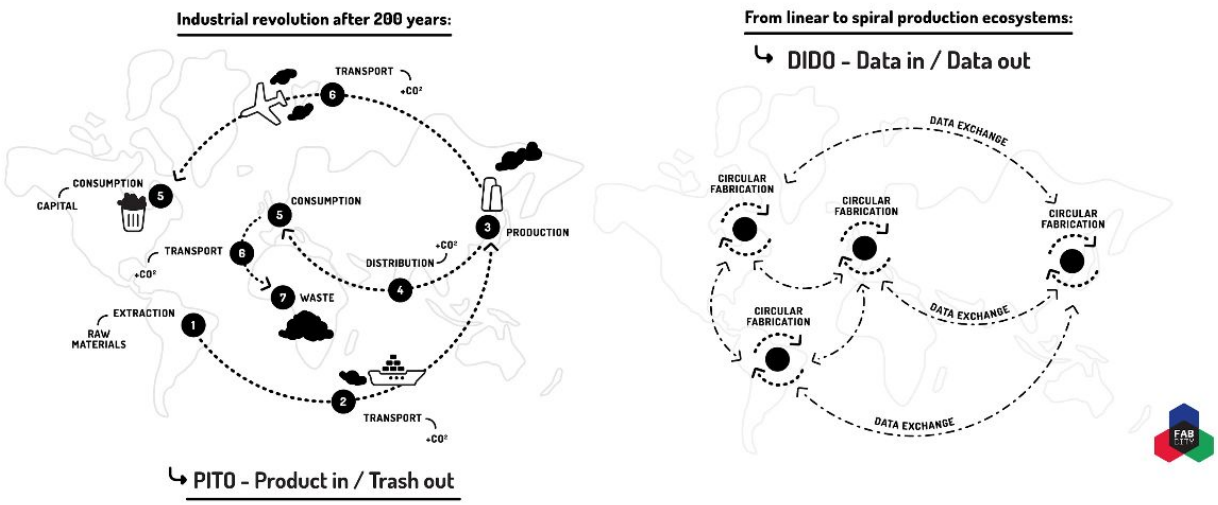

Figure 01 ' From "PITO to DITO"' (Diez, 2018)

The key ideas taken from the theoretical debates are related to a sustainable vision of the future in which economic growth is limited by both environmental and social justice (see figure 2). For a more solid groundwork in evaluating socio-environmental sustainability in relation to economic growth, the Framework for Strategic Sustainable Development (FSSD) (Robert et al., 2002), developed by the Swedish nonprofit organization The Natural Step, provides sustainability principles, practical tools and evaluative checklists used in consulting and environmental management procedures. It is seen as a "source-oriented" paradigm rather than "effect-oriented" paradigm, as such it is "*estimating what nature can tolerate and then set standards for emissions and resource use*" (Tukker et al., 2008: 19, 25-26). This "source-oriented" paradigm establishes a set of principles

which are general and therefore make sense for all stakeholders; they offer concrete guidance for problem solving; and they offer appropriate indicators for monitoring and assessment (FSSD, Robert et al., 2002).

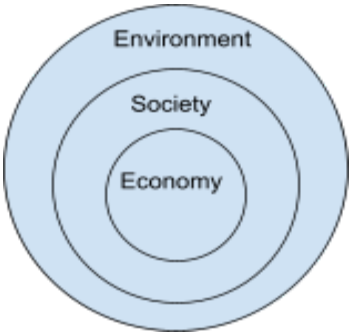

Figure 02 'Conception of sustainability and its dimensions'
Source: author, origin unknown; possibly derived from Daly et al., 1989, in Kohtala, 2016.

Fab Cities' full stack

Pop Machina Maker Academy is made in the context of the Fab City Global Initiative, which is envisioning and constructing possible urban futures by working on multiple and interconnected scales. Fab Lab Barcelona's approach for the implementation of the training programme is aligned with this vision. The training programme will empower and guide the local communities in the pilot cities to deploy projects using the collaborative production and circular economy frameworks.

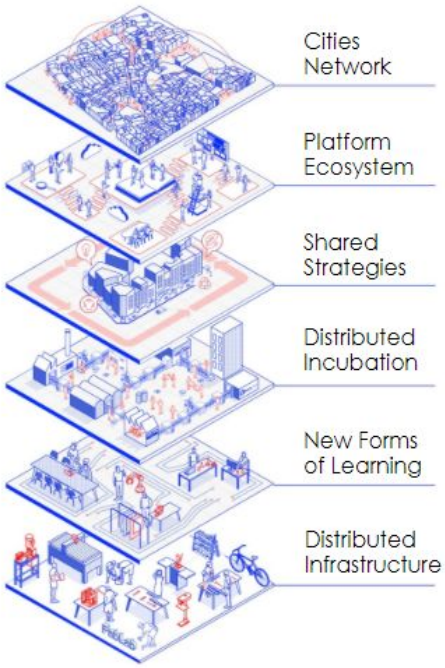

Figure 03 'Fab City Full Stack approach' Source: Diez, 2018

5.2 Implementation

The Future Learning Unit (FLU) team at Fab Lab Barcelona offers citizens the necessary methodology, resources and technology to develop. They can learn key skills and competencies for an uncertain future, accelerate the transition to a circular economy and become digital social innovators who respond to the challenges posed by the Sustainable Development Goals. At PMA we use the FLU framework (in continuous evolution) as a pedagogical tool that facilitates the development of the skills and competences defined in the Learning Dimensions section. The FLU framework is based on 3 pillars: attitude, knowledge and challenge.

Attitude To create the ideal learning ecosystem for each of the participants and for the Maker Champions (MCs) community so that they develop a positive attitude towards their own learning during the Academy and that this continues after the Academy with the rest of the community. We facilitate this by:
building and engaging the community.
offering assistance during the evaluation process.
supporting the person before, during and after the sessions.
designing a hyperconnected learning environment so they can have a similar learning experience whether they are in a Circular Maker Space (CMS) or at home.
providing references, contacts and inspirational leaders from the circular open networks.

Table 02 'Future Learning Unit Framework - Attitude' (Source: the author)

Attitudes to learning, and the perceptions and beliefs which determine them, have a significant influence on learning behavior and on learning outcomes. Successful learners develop insightful beliefs about the learning processes, their own abilities and the use of effective learning strategies, which together have a facilitative effect on learning (Seel, 2012)

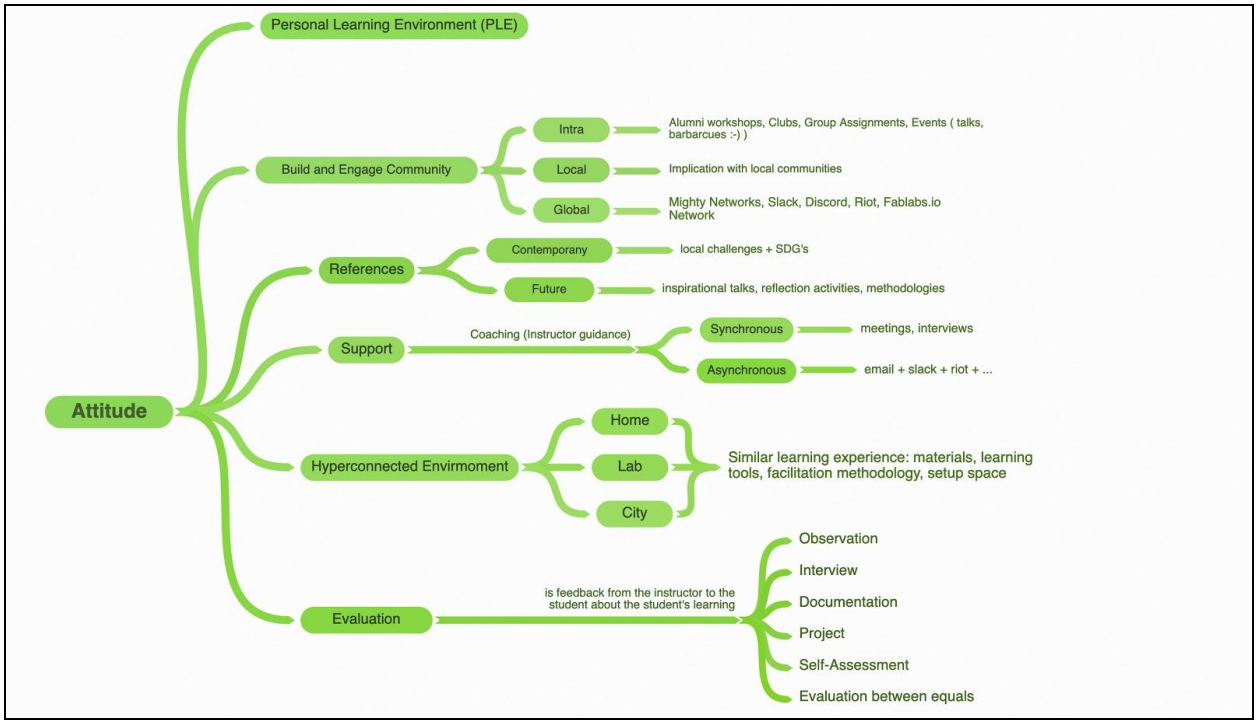

Figure 04 'Future Learning Framework: Attitude' (Source: the author)

Knowledge

To provide the appropriate knowledge in each of the sessions and stages of learning. This is:

To design the facilitation methodology for the instructors taking into account the three stages of learning: guided, instructional and autonomous.
To provide the best tools to follow the Academy (materials, inventory and distance learning technology).
To offer the best content related with the PMA topics (documentation, media, references and master classes).
To bring the experience of the IAAC team but also of other relevant people and institutions from other open networks (Fab Lab Network, Distributed Design Market and DSI Scale.
To design active learning experiences in a 100% online learning model with a STEAM approach and learning-by-doing principles.
To give the right assessment for each of the participants based on the activities and the documentation they produce.

Table 03 'Future Learning Unit Framework - Knowledge'

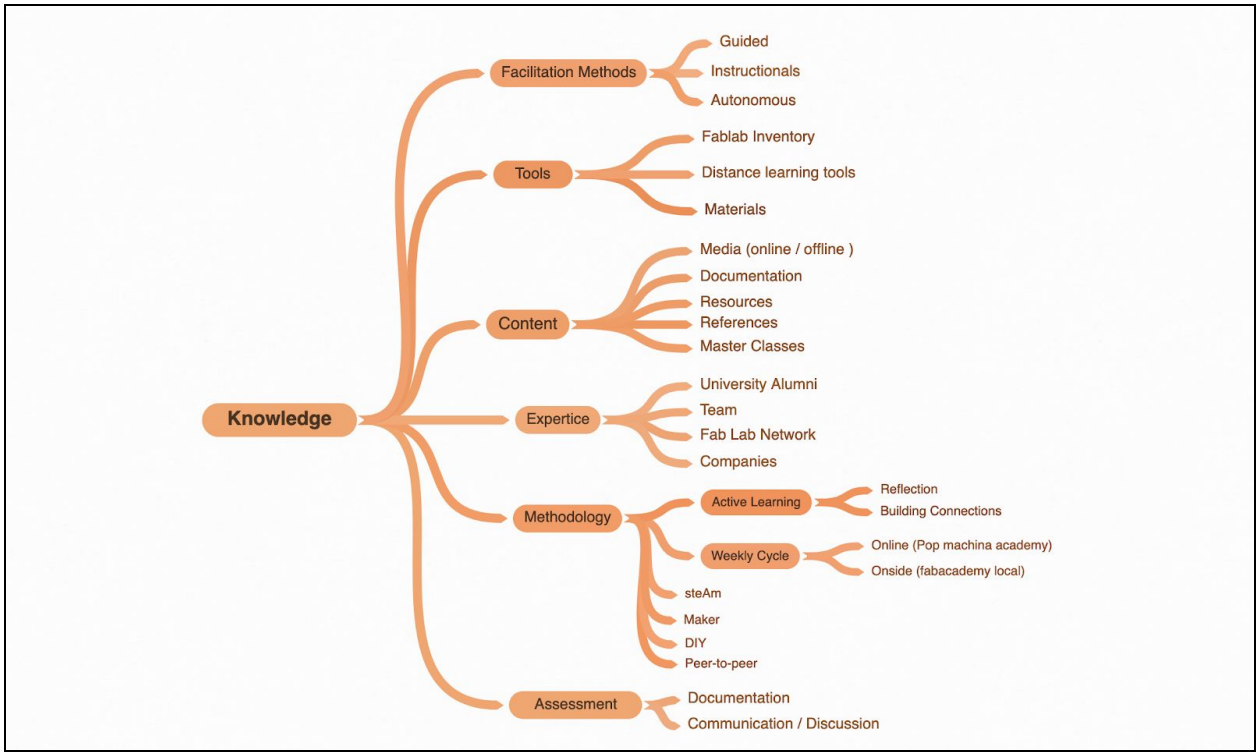

Figure 05 'Future Learning Framework: Knowledge' (Source: the author)

Challenge

To help each of the participants and the community as a whole to address challenges that matter. This is:

To provide research tools and techniques that can be applied globally but also in a local context and help define, conceptualize and address challenges. This is also learning that is acquired at a personal level.
To have a maker-center learning approach in the execution of the challenge.
To mentor each of the local MCs during the challenge activities trying to connect them with other communities, key partners or topic experts.

Table 04 'Future Learning Unit Framework - Challenge'

Complementary the nine PMA principles (listed in table 4) make the PMA Framework through which the PMA was developed, designed and facilitated. Therefore, the PMA framework: (1) Helps to achieve the Pop-Machina objectives (as described in the Grant Agreement, number 821479). (2) Is a tool which the MCs of the seven Pilot Cities can rely on to build the local communities, support the implementation of the Pilots and develop local CMS. (3) Is an open knowledge repository to empower citizens in a collective manner to contribute to a greener, more sustainable and circular Europe. (4) Allows new communities to adapt to technology trends (digital fabrication, electronics, data sensing and coding) in a novel way that can ultimately contribute to (5) a positive social impact.

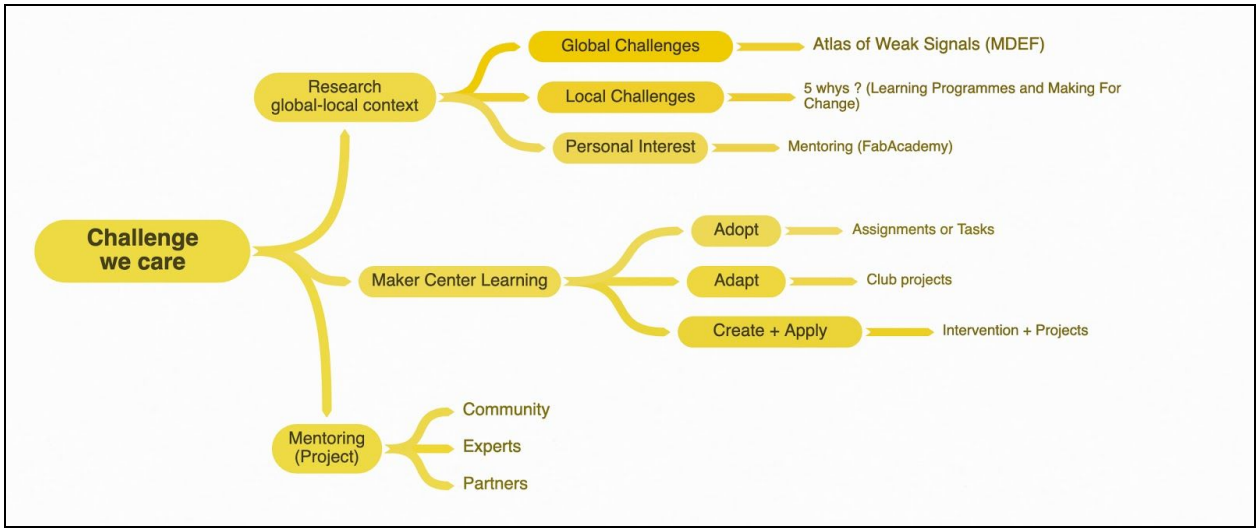

Figure 06 'Future Learning Framework: Challenge' (Source: the author)

BOTTOM-UP IN COMMUNITY	Everything is co-designed and co-created with communities
OPEN KNOWLEDGE	Harnessing the power and assets of all interested parties to tackle social challenges through reusing, remixing and building on top of existing distributed knowledge
OPEN HARDWARE	Everything is made with freely available hardware to tackle social challenges
OPEN DATA	Capturing, using, analyzing and sharing freely available data to tackle social challenges
LOCAL - GLOBAL NETWORK	Growing locally applied and globally distributed networks through technology from the bottom up to tackle social challenges
LEARNING ECOLOGY	Learning happens everywhere and at any time
DIGITAL SOCIAL INNOVATION	Addressing social and environmental challenges through Digital Social Innovation
INCLUSIVITY & EQUITY	Supporting inclusive and equitable environments in which experiences of individuals leads to self-empowerment
CIRCULARITY	A holistic approach to the manufacturing and design process. Taking into account f resources, processes, assembly & disassembly, repair, further exploitation etc.

Table 05 'Pop-Machina Academy Principles' (Source: the author)

5.2 The Strategy

The Pop-Machina Academy is a training programme co-designed to deliver the knowledge and making skills future trainers in the field will need to enable actions for circular making and sustainability. Within the project's seven Pilot Cities, trainers will engage with their local communities in a collaborative effort for implementing new strategies and approaches towards circular ecosystems, with solutions based mainly on digital fabrication. The training programme has focused on stimulating practical know-how, following the principles of STEAM learning and the learning-by-doing methodologies. This has been enriched with thematic topics addressing business, circular and collaborative manufacturing, gathering learning within the consortium and beyond as well as vocational teaching from the Maker Movement. The Academy activities

were impacted by the global COVID-19 pandemic, yet all activities were achieved. Local regulations and mobility restrictions meant activities were moved online yet many activities, including the hands on elements, were still properly incorporated. The content reflected the COVID-19 experience of the participants as it encompassed a blend of online and applied physical home-based learning methods aimed at stimulating interactive, practice-based capacity building and peer-learning. The Academy was co-developed and deployed by Month 20 with selected local community Champions to support the pilot operations.

SWOT Analysis

The SWOT analysis framework was used to assess strengths, weaknesses, opportunities, and threats. In the PMA, the SWOT analysis serves for the iterative reflection and adaptation through the Academy and as an analytical tool for the final evaluation of PMA. Furthermore we also introduce SWOT to the MCs as a tool to implement in their CMS for any activities conducted as well optimization of the CMS.

Evaluation

For a holistic evaluation of the PMA it was necessary to consider feedback from the participants. Hence at the start of the Academy the aspiring MCs received an online form in which they have the opportunity to self evaluate their current skills, competences (learning dimensions) and expectations of the Academy. After the completion of the Academy the MCs revise their development in terms of their learning dimensions and give feedback about the implementation of the Academy. The figure below showcases the personal and community progress the MCs can undergo. However this process may change, and adapt depending on the person or communities.

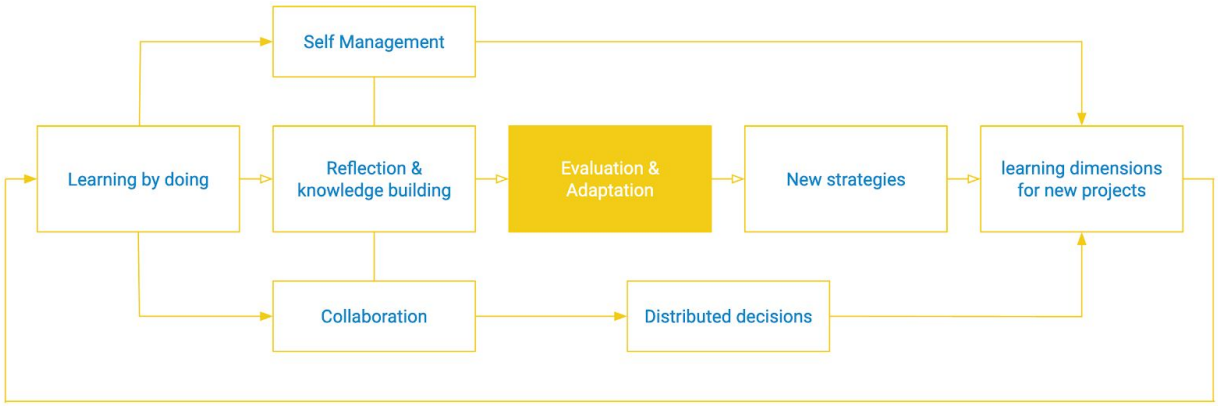

Figure 07 'Framework for community engagement processes' (Source: the author)

5.3 The Approach

The following subsection explores four key methods used to approach the Pop-Machina Maker Academy. The existing methods used are based on the future learning framework, which was largely employed to equip trainers with training skills to support the advancement of local changes. The approach is the overarching guide for the local Champions in each Pop-Machina City during the instructional, guided and autonomous phases. This guide functions as a framework to analyse local challenges and facilitate Workshops which address these. During this process we suggest that each local Champion use the approach to create activities within the CMS.

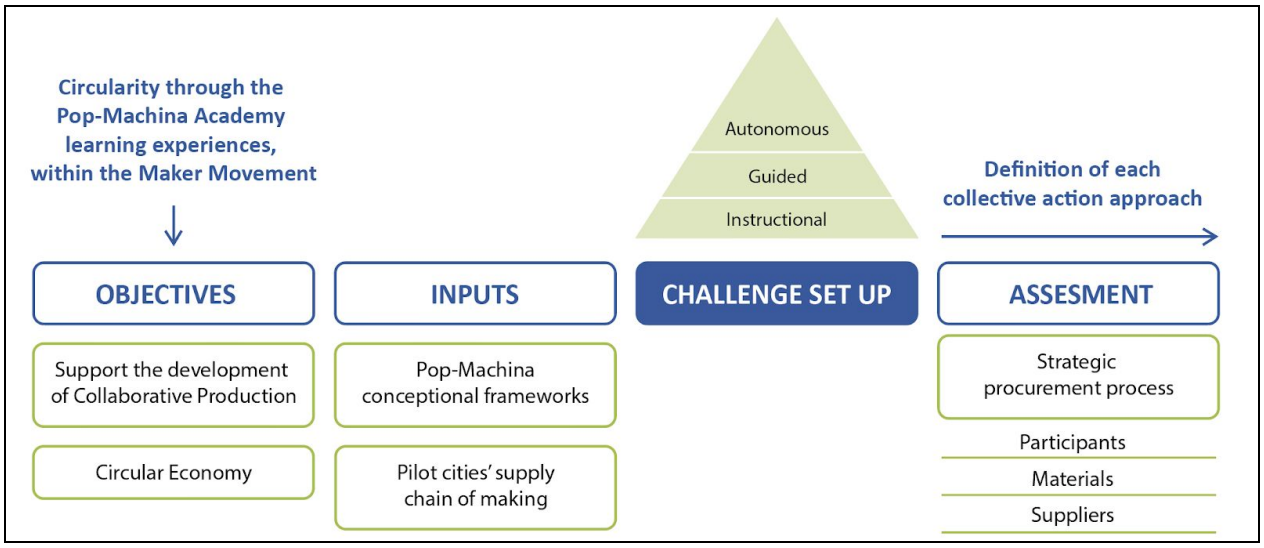

Figure 08 'The Academy phases: Instructional - guided - autonomous' (Source: the authors)

5.3.1 Community Building

At the heart of the Pop-Machina Academy (PMA) creation there is the attitude of caring people from the Maker Community concerned with environmental and social problems within the makerspaces practices. The training programme goes beyond learning about digital fabrication tools; it focuses on the making community, as a means and as a goal by itself. Thus, community building is an important component of the PMA. The people centred approach follows the rationale of building a "community of practice". The PMA is training people to become trainers of Circular Maker Spaces (CMS). These CMS are not anymore aimend to be the "traditional" makerspace. The CMS is a space for communities coming together, sharing knowledge about "circularity", concerns about real world challenges and collaboration. The collaborative effort on making can be as simple and powerful as coming together for learning how to make compost for your garden. The oversimplified assumption of "making" within the scope of PMA is that *people* (Circular Maker Champions, or "CMC") come before *machines* (e.g. Computer Numerical Controls, or "CNC").

5.3.1.2 Communities of Practice

"Those promoting participatory action-research believe that people have a universal right to participate in the production of knowledge which is a disciplined process of personal and social transformation. In this process, people rupture their existing attitudes of silence, accommodation and passivity, and gain confidence and abilities to alter unjust conditions and structures" (Paulo Freire, in Smith et al, 1997:xi). The key pillars for community engagement are citizen engagement, communication, capacity building, collective responsibility & decision making and a pool of tools & resources. We are following a two-pronged approach to community engagement. The digital component not *only serves the purpose of communicating the project but also offers the community a "space" for a shared knowledge repository and to congregate when not being able to meet physically. It is essential to support

both levels: the digital (online) as well as the physical (offline) to ensure the sustainability of the projects and their communities, especially after the project has been completed.

The understanding that participation leads to a sense of community increases the sense of belonging. Crucial though, is that the sense of belonging and identity is formed in relation to others. Which means that social roles and group membership is shaping the way we view ourselves and our affiliation to a larger social system. (Erikson, 1993). This can effectively encourage others to participate and can then lead to global development. The sense of belonging and understanding one's own identity gives people reasons for "doing things" (Appiah, 2018). For the Academy, the indicators for the training programme rely on a sense of fairness, trust, mutuality, learning and capacity building. There might not be a lack of citizens who are willing to partake in social practices for change in their neighborhood. Nevertheless the complex problems are hard to grasp as a single individual. Surveys in the United Kingdom, for example, have shown that the proportion of citizens who are engaging in their city in neighborhood activities has stayed stagnant. However, the sense of belonging has declined by four percent in the last eight years (Large, 2020). This is not only the case in the UK, but can be seen as a global trend (Inglis & Donelly, 2011).

Capacity building happens when communities are engaged. Thus, it is essential to connect these single actors who have the urge to participate in change-making practices, but simply do not know how. The challenge which needs to be tackled is that there is a lack of current participation in the projects. A local participatory ecosystem can encourage citizens by making practical tools for collective engagement available. This means they are encouraging projects which support knowledge sharing i.e. cooking, repairing, reusing and play for everyday practices. The common practices should be included in the fabric of everyday lives of citizens and they should be mutually and collectively beneficial. The city has the potential to become cohesive, inclusive and collaborative with a circular local economy. Co-designing or co-creating this approach in the public realm, together with the citizens, opens the possibility for a change to more resilient cities and innovative social ecosystems (Kimbell & Baily, 2017). At present, it is often only areas such as parks and libraries that are considered public space. The Pop Machina initiative would like to prove that public makerspaces, kitchens and gardens can likewise be considered as areas for citizen participation and collaboration. Therefore defining themselves as public space too. Which leads to the idea that the neighborhood is a space where citizens feel like their actions are contributing to a collective objective. This includes the idea that they are part of creating diverse spaces, projects and networks and helps to maintain the neighborhood. The challenge which is being faced is how to design and build the physical, technical and social infrastructure to enable the co-creation of a resilient future (Britton, n.d.). The CMS can act, in this sense, as a participatory ecosystem. A participatory ecosystem supports making, sharing and informal mentorships with low barriers for participation. The key is to make each member feel part of a network and make their contribution matter (Jenkins, 2019). A sense of belonging to a group can be encouraged through shared understandings or visions and face-to-face interactions support this development. The local connection and attachment to one's own identity compliments the adaptation to globalisation through supporting each other (Inglis & Donelly, 2011).

5.3.2 STEAM Education & Learning by Doing

One key concept for the Academy is STEAM. STEAM is an educational approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics as access points for guiding student inquiry, dialogue, and critical thinking. The end results are students who take thoughtful risks, engage in experiential learning, persist in problem-solving, embrace collaboration and work through the creative process. These are the innovators, educators, leaders and learners of the 21st century. There are educational methods that offer options to align the power of people to produce change with the power of the unprecedented technological capacities we have today. STEAM is an educational method for 21st-century literacy, which allows students to investigate, read and understand trends and tendencies, in fields such as ecology, media, and technology[7]. The STEAM approach aims to guide students' inquiry, dialogue, and critical thinking through Science, Technology, Engineering, the Arts and Mathematics. This educational approach arises as a reaction to an increasing demand in the job market for professionals with knowledge in science, technology, engineering, and mathematics. Its predecessor, STEM, focused on teaching students the skills needed to fill this gap. However, the realisation came that an understanding of these fields alone is not enough. Students also need to be prepared to apply their knowledge creatively and in an innovative way. By adding the field of 'Arts' to the STEAM method, there is emphasis on students learning the necessary creative skills to find innovative solutions to today's problems. Asking questions with curiosity and being creative in the finding of the solutions is at the heart of this approach. It is a collaborative 'hands-on learning method', that believes in 'learning by doing', therefore bringing learning to life. Engaging in experiential learning and hands-on activities, problem-solving, collaboration and creative processes are embraced.

5.3.3 Open Source

The Maker Movement is known for its beliefs in an open source mentality. Open Innovation platforms (e.g. the Distributed Design Market Platform[8]) and toolkits that help makers and designers to go from idea to prototype, and from prototype to products and markets are vital for a collaborative future. Essentially this means that content created, either digitally or physically, is licensed under Open Innovation (e.g. Creative Commons[9]). A range of blueprints, source code and Bill of Materials are publicly available for others to use. Depending on the specific license this can imply that the original files can be altered or not; and whether they can be used for commercial purposes or not. Ultimately the open source mentality in the maker movement contributes to the accessibility of knowledge. It empowers people to make and design. People can add to the process by adapting and remixing according to their context. The benefits of such can be illustrated with the example of Precious Plastic: Dave Hakkens has shared the documentation of the plastic recycling machines from the very outset. Through sharing his work other people were able to replicate and advance the work. To this day thousands of people have worked on this project and supported the development of small and large scale recycling machines. For the PMA the same open source mentality is in place. All content is available online and for free, for people to learn, share, adapt and remix according to their needs and desires.

[7] Maeda, J. (2011), STEM to STEAM: The past and future of the arts, design, and the STEM fields, Retrieved from http://stemtosteam.org/
[8] https://distributeddesign.eu/
[9] https://creativecommons.org/

5.4 The learning dimensions, Making and Facilitation Skills

Among other skills, creativity is widely acknowledged as vital for progress in knowledge societies and innovation-driven economies (OECD, 2018). It is also increasingly valued in relation to individual and collective identity, mobility, and wellbeing (Durham Commission on Creativity and Education, 2019). At the individual level, creativity is thought to embrace curiosity and intellectual restlessness, a tolerance for uncertainty, risk, and ambiguity, and the capacity to be adaptable and flexible. These dispositions facilitate higher learning, long-term employability, and upward social mobility. Creativity can also benefit physical fitness, emotional resilience, mental health, confidence, agency, and engender a sense of empowerment. At the collective level, creativity helps to promote social engagement, community identity and cohesion, stimulates economic growth and supports the functioning of democratic societies.

Fab Lab Barcelona has been extensively testing and revising the Learning Framework described previously, with different target groups over the past several years. To summarize the Future Learning Framework (FLF) includes: attitude, knowledge and challenge as its main pillars. The FLF accompanies people with the methodologies, resources and technologies to learn and develop skills. In recognition of this aspect of pedagogy, may contribute to 'why' we implemented the Academy as we did. Ultimately, the pedagogical approach follows the rationale of "learning to learn" as means for "lifelong learning" (Lucas, 2020).

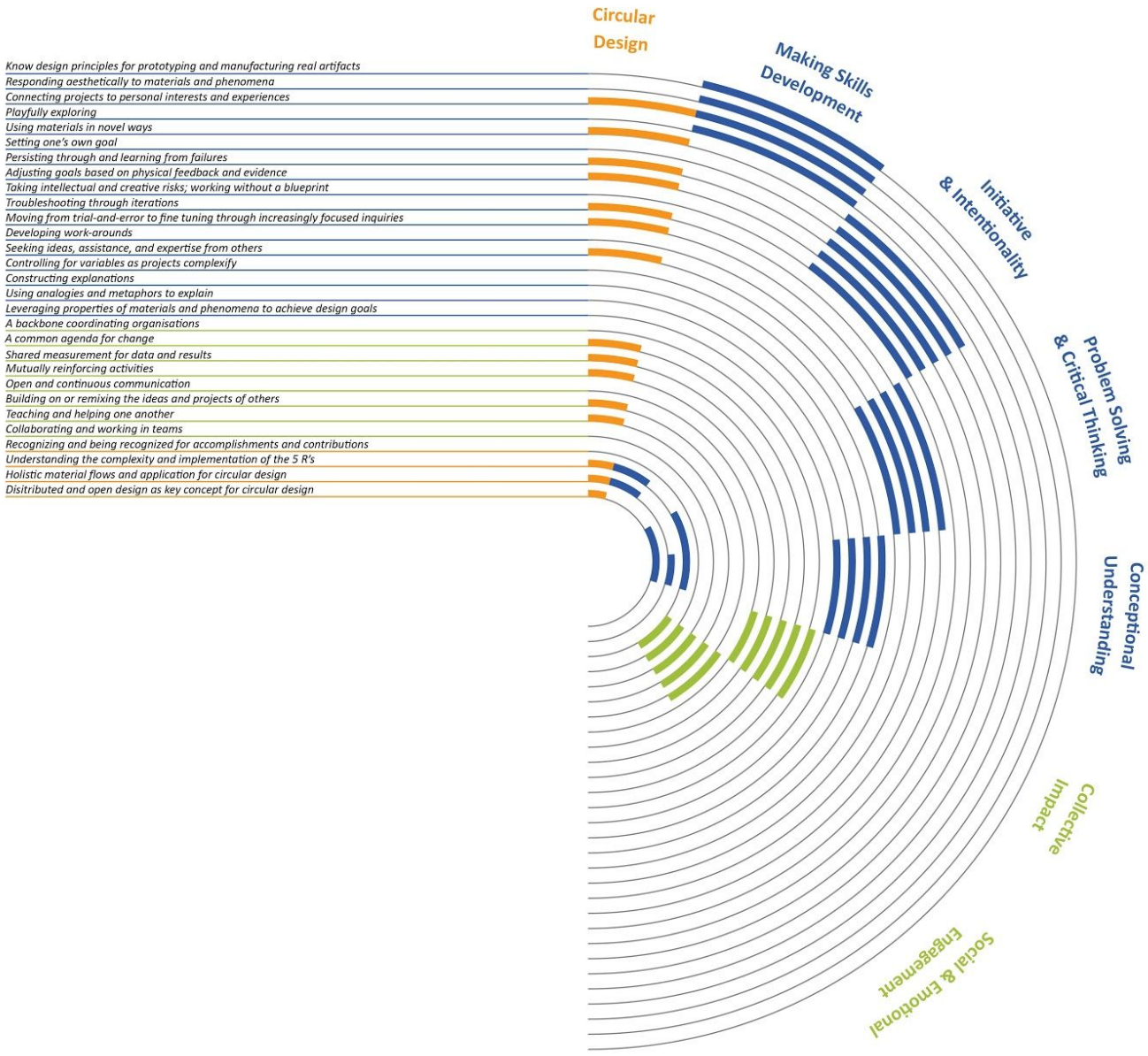

Figure 09 'Pop-Machina Academy Learning Dimensions' (Source: the authors)

The PMA learning dimensions contribute to accelerate the European Circular Economy Action Plan[10] making circularity work for people, regions and cities and to accelerate the Digital Education Action Plan[11] enhancing digital skills and competences for the digital transformation.

5.5 The "challenge" setup

The general objectives are: (1) to create an immersive experience with Fab Lab Barcelona, becoming familiar with the staff and the makerspace. (2) To assess tools and skills to rethink and redesign project ideas in a cross-sectional and interdisciplinary way. (3) Inspire new ways to use technology and solve problems. (4)

[10] https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf
[11] https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan_en

Acquire resources for self-learning, collaborative production and circular economy. (5) Create a solid group capable of helping each other and supporting the Pop-Machina Pilot Cities' deployment. And lastly to (6) emphasize the connections between the different projects to create a group culture. The challenge for the PMA for our team is to facilitate building an autonomous community of MCs.

In the short term building a community of MCs serves the purpose of facilitating peer to peer exchange of knowledge. As all of the MCs are going through the same process and similar experience of learning. Each of them are part of the process of creating a CMS, they will be able to collaboratively address questions and find solutions to common issues. Gradually they will become autonomous. Which means that in the long term, a community of MCs allows us, as initiators, to take a step back. In practical terms this means that the Champions can rely on each other during the CMS life cycle. Which does not mean that the IAAC/ Fab Lab Barcelona team will not support if needed. It only means that the Champions, before having to come to us, will be able to rely on their community for support. The longevity of the CMS e can be therefore supported by having a strong bond between the MCs thus building a community of practice. In addition, the community will grow both naturally and locally. The Champions are encouraged to share their knowledge locally, to grow their community.

The participants for the PMA were selected by the partners in each respective city. Together with Julie Metta, who supports the Pilot Cities, we have created a participant profile. This profile should support the cities to find their MCs. Each city had their own means of reaching out to acquire their participants. The list below is non-exhaustive, but it summarizes the important attributes a maker should have to be selected for this specific training programme.The Maker Champion is an adult (18+) who is (in order of priority):

1. Motivated
2. Willing to learn and understand new concepts (self-learning and learning by doing)
3. Willing to share and spread knowledge with others
4. Available (has time to dedicate)
5. Autonomous
6. Fairly confident in their use of English (at least reading and listening)
7. Able to teach and share learning experiences
8. Interested in the Maker Movement and culture of reuse
9. Maker skills (desirable): project management, basic knowledge of electronics and Arduino, basics of design, digital fabrication and coding. These are a great asset for the Maker Champions to be easily immersed into the training
10. Like-minded and friendly

These are merely suggestions of what can constitute a useful maker, or community Champion. There is no "one solution" or "one specific person" who is the perfect fit for this role. Especially taking into account that people can develop these skills over time. Hence, the core attributes or characteristics of the person are being interested, open and curious. After this everything else may be learned. At Fab Lab Barcelona we often observe that a person's true characteristics become obvious later in the project life-cycle. There might be surprise candidates who did not seem suitable for the position at the beginning but turn out to be a good fit, and vice versa. In general, we suggested having as many participants for the PMA as possible. This gives room for people to "drop out" if they lose interest or to share the workload. A local team of MCs can

support each other directly. Each Maker Champion can take a different role in the CMS based on their interest and expertise. Over time some people may naturally fall into the role of the "technician" or others may lead the workshops. Some other people might have better organisational skills and therefore would fit more naturally into a coordinator or mentor role . These things do need time and the given amount of time will often depend on the person. . Another factor which needs to be taken into account is whether the participant is extroverted or introverted and how this will influence their position in the CMS.

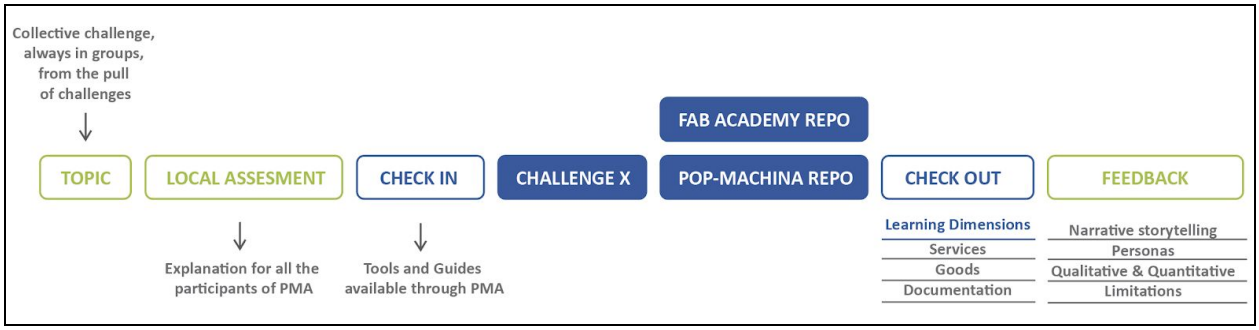

Figure 10 'The PMA Challenge setup' (Source: the authors)

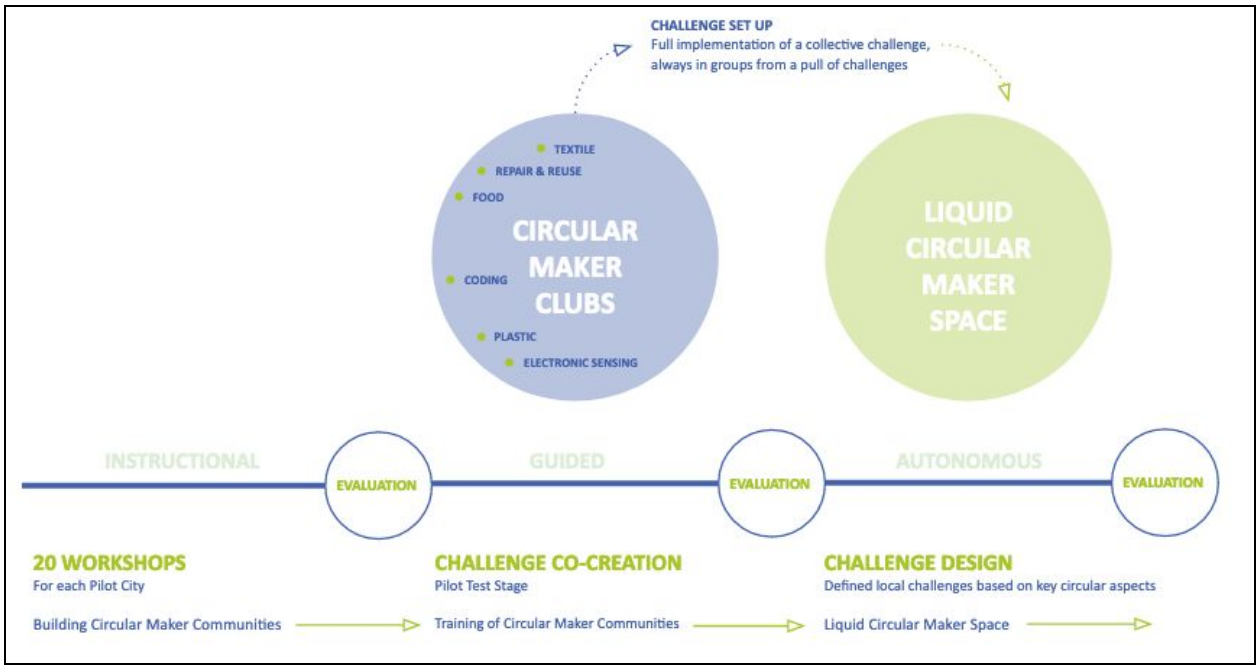

Figure 11 'The PMA Challenges timeline' (Source: the authors)

5.6 Outline and structure of the Pop-Machina Academy

The PMA started in June 2020 and lasted until the end of October 2020. The participants of the Academy gathered weekly, which makes a total of 17 sessions. Taking into account that there were no sessions during the month of August. The weekly sessions took place on Thursday mornings from 11:30 am until 13:30 pm CET. The PMA follows, as mentioned above, an instructional, guided and autonomous strategy. The months June, July and September were instructional. In these sessions, we, as facilitators, shared information,

resources and did workshops together with the MCs. In October the guided phase started. Which means that the MCs were asked directly to implement their gained knowledge in a practical way. In the guided phase the Fab Lab Barcelona team, as facilitators, took a step back. The role changed from giving direct instructions to merely giving context to the activities that had to be conducted by the MCs themselves. We will elaborate further on the immersive training, and instructional phase during October later in this report (page number 75). The autonomous phase starts after completing the Academy. This means that the MCs are empowered to make their own decisions on which path to take. Together with the municipalities, stakeholders and citizens, they can co-create the CMS. The MCs can count on their peers to give each other support and share best practices. However, we have emphasized that we, as a Fab Lab Barcelona team, will be part of this group of peers. The longevity of the CMS is dependent on the community of practice or the community Circular MCs. Only through sharing experiences, failures, learnings and best-practices between the CMS can they thrive to their full potential. At the core of every CMS are the people. The people are the ones which 'make things happen'.

6. WHEN: The Pop-Machina Academy in Practice

The Pop-Machina Academy (PMA) was planned to be a one-month-long immersive learning and training experience conducted in Fab Lab Barcelona in October 2020. However, the training was transformed to be completely online and remote due to the constraints and travel restrictions which came simultaneously with the covid-19 pandemic. This section will be first introduced with the life-long learning reference as a learning framework in pedagogy, followed by the PMA structure, tools, material and content.

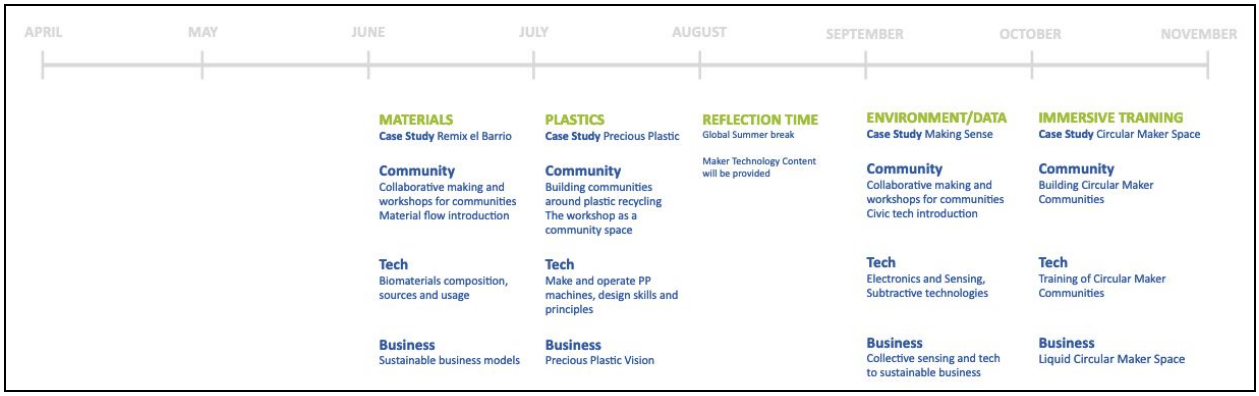

Figure 12 'Pop-Machina Academy Curriculum' (Source, the author)

As shown in the timetable above, June was dedicated to materials, July to plastics, September to Environment and Data and, in October, the focus shifted to immersive training. Each meta topic was addressed in the weekly sessions. The overall aim was to showcase a practical example based on the topic with a case study, and then contextualize from three points of view: community, tech and business. We will elaborate on this in section "3.4: Content and Materials". The mandatory for the Maker Champions (MCs) to successfully accomplish the Academy was 12 hours in the online curriculum, and 12 hours hands-on, offline, self-organized research and documentation. During the month of October, the time requirement was higher. As seen in Figure 12 'PMA Time Dedication in October", the initially planned dedication was around 60

hours. After receiving feedback from the MCs, we have collaboratively decided to lower the number of hours. Needless to say, there was an emphasis on the importance of dedicating time throughout the immersive training. Unfortunately, many of the MCs do have other responsibilities within and outside of Pop-Machina, which at times complicated attendance. In the end, we have kept the same amount of curriculum hours as the months before. The external hours for the implementation of work throughout their local challenge setup was left to be decided by the local Maker Champion team.

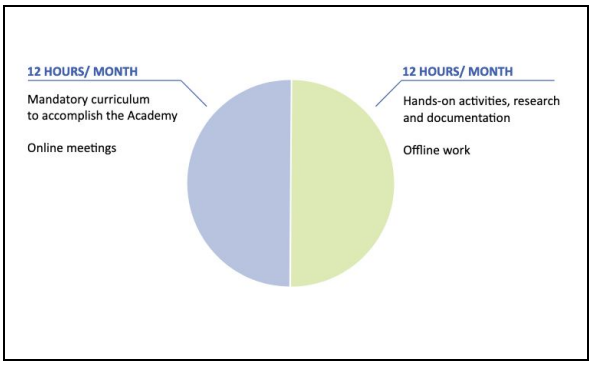

Figure 13 'Pop-Machina Academy Dedication June-September'

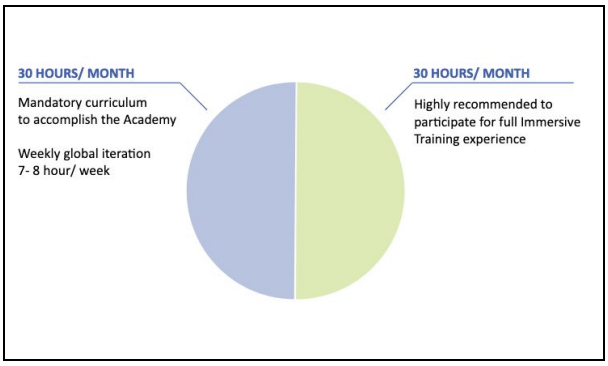

Figure 14 'Pop-Machina Academy Time Dedication October'

Each session of the PMA was planned in advance with the network of knowledge partners of Fab Lab Barcelona. We connect the participants to an open network, which includes the knowledge partners in the Pop-Machina consortium as well as the network which Fab Lab Barcelona is connected to. Fabacademany is one of these networks – this includes the Fab Academy network as well as Fabricademy. Furthermore, we are linking our work from other European Horizon 2020 projects in example SISCODE[12] or REFLOW[13]. The aim of this is to emphasize that there is not a single source of knowledge or input, but many. By making the participant aware of that, we hope that the MCs know where and from whom to find necessary information. The actors in the networks believe in open knowledge, which is strongly linked to the mentality of open-source and the Creative Commons in the maker movement. Beyond and directly connected to the maker movement are other communities of practice. Digital Social Innovation, 3D printing, or Distributed Design are examples of such. All of them have their areas of expertise and existing networks. In the Academy, we acknowledge those and link to them. We will further elaborate on open networks, which are showcased through case studies, later in this report.

For the planning of the PMA session content, we relied on simply setting up an Excel sheet. The Excel sheet includes the topic, speaker, structure of the session, status of planning, recommended readings, assignment, and feedback.

[12] https://siscodeproject.eu/
[13] https://reflowproject.eu/

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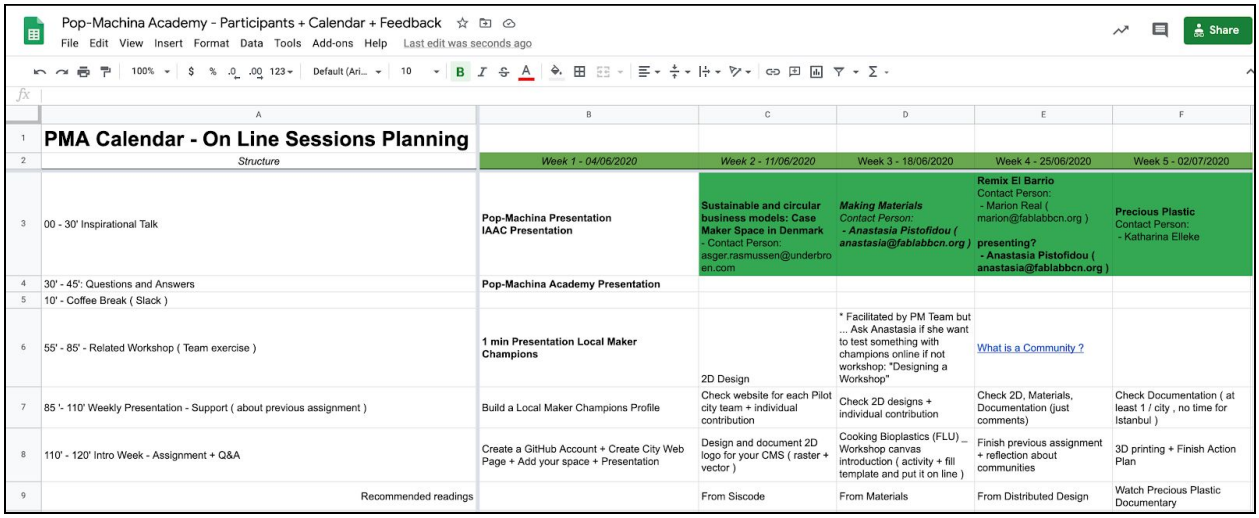

Pop-Machina Academy - Participants + Calendar + Feedback

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	A	B	C	D	E	F
1	**PMA Calendar - On Line Sessions Planning**					
2	*Structure*	*Week 1 - 04/06/2020*	*Week 2 - 11/06/2020*	Week 3 - 18/06/2020	Week 4 - 25/06/2020	Week 5 - 02/07/2020
3	00 - 30' Inspirational Talk	**Pop-Machina Presentation IAAC Presentation**	**Sustainable and circular business models: Case Maker Space in Denmark** - Contact Person: asger.rasmussen@underbroen.com	***Making Materials*** *Contact Person:* ***- Anastasia Pistofidou (anastasia@fablabbcn.org)***	**Remix El Barrio** Contact Person: - Marion Real (marion@fablabbcn.org) **presenting? - Anastasia Pistofidou (anastasia@fablabbcn.org)**	**Precious Plastic** Contact Person: - Katharina Elleke
4	30' - 45': Questions and Answers	**Pop-Machina Academy Presentation**				
5	10' - Coffee Break (Slack)					
6	55' - 85' - Related Workshop (Team exercise)	**1 min Presentation Local Maker Champions**	2D Design	* Facilitated by PM Team but ... Ask Anastasia if she want to test something with champions online if not workshop: "Designing a Workshop"	What is a Community ?	
7	85 '- 110' Weekly Presentation - Support (about previous assignment)	Build a Local Maker Champions Profile	Check website for each Pilot city team + individual contribution	Check 2D designs + individual contribution	Check 2D, Materials, Documentation (just comments)	Check Documentation (at least 1 / city , no time for Istanbul)
8	110' - 120' Intro Week - Assignment + Q&A	Create a GitHub Account + Create City Web Page + Add your space + Presentation	Design and document 2D logo for your CMS (raster + vector)	Cooking Bioplastics (FLU) _ Workshop canvas introduction (activity + fill template and put it on line)	Finish previous assignment + reflection about communities	3D printing + Finish Action Plan
9	Recommended readings		From Siscode	From Materials	From Distributed Design	Watch Precious Plastic Documentary

Figure 15 'Pop-Machina Academy Calendar - Online Sessions Planning'

The second part of the PMA Calendar is the list of the participants and their attendance, including their contact information and link to the documentation. This serves as a continuous method of quantitative and qualitative data collection in relation to our MCs. The attendance, participation and documentation guides us in the evaluation process of the MCs.

6.1 Tools

Communication tools

Throughout the duration of the PMA we relied on two main ways of communication: synchronous and asynchronous. For each way of communication, we used different tools. The synchronous communication took place during each session. As the name "synchronous communication" suggests, synchronous communication is in the moments in which all participants and ourselves are present. We used the online tool Blackboard[14], which is an already established tool in the Pop-Machina consortium. Blackboard is a virtual online collaboration and web conferencing tool. Like many other online web-conferencing tools, it provides screen sharing, the possibility to "raise hands", and the ability to divide the group into separate breakout rooms.

In combination with this, our main tool for asynchronous communication was Slack[15]. Slack is already commonly used in many companies for communication-based topics or areas of interest, between and among teams. Using an instant messaging tool such as Slack can encourage more informal conversations, and information flow is more omnidirectional. In comparison, using email services in the context of communities is rather one-directional. Emails were regularly used to share information about important updates. In general, emails are a formal way of communication.

[14] https://www.blackboard.com/
[15] https://slack.com/intl/en-es/

Documentation tools

The documentation of the content took place in three spaces. Firstly, all documents, presentations, references and monitoring tools such as the PMA Calendar are internally saved in GoogleDrive. GoogleDrive is a cloud service developed by Google which allows users to save, store and share documents across devices. GoogleDrive includes sharing options that provide the possibility to decide if external users are allowed to view or edit documents. We have chosen to use this service even though Google has a divided reputation within the maker scene. Google, being a worldwide acting corporation, takes liberties with people's privacy and stores personal data. It is known for tracking and monitoring many of its users' online presence. The reason why we have chosen this tool is merely out of convenience and accessibility. GoogleDrive is already being used inside IAAC and many people are familiar with the usage of Google Services. However, we see the usage of this service as critical, and for further iterations of the Academy we would suggest finding alternatives. All presentations and almost all graphics used in the PMA were made in Google Slides, another service provided by Google and included in the GoogleDrive. The advantage of using Google Slides, Docs or Sheets is that, through giving editing access, people can collaboratively work on documents without having to be in the same room. GoogleDrive was used internally within the IAAC team.

Hack MD[16] is being used to share documents, external and internal presentations and links to references with our MCs. HackMD is a collaborative markdown documentation tool. It can be connected to Git repositories, can integrate VSCode, and has many more useful extensions which are commonly used in the maker and coding community. Documentation can be shared online for everyone to access it, or kept secret with limited access rights. The access rights can be granted by the creator of the documentation. Using HackMD for the PMA supported our idea to use as many commonly used practices with our MCs as possible. It makes sense to review best practices in the existing maker community and do the same with the MCs of Pop-Machina. With that, we can support a basic understanding of workflows and smooth transition for the Champions to be part of the maker community.

The initial idea at the start of the Academy was to organize all necessary information which could be needed as a Maker Champion in a Gitbook[17]. Gitbook is similar to HackMD, a markdown documentation tool, and belongs to the "git family" like Github[18] and Gitlab[19], all used in the maker community. Git is a free and open-source distributed version control system which enables people to handle projects. Gitbook provides the possibility to embed images, external documents, and all content can be saved in chapters: hence its being called "book".

Machina: The PMA Handbook is dedicated to the local Champions of the seven Pop-Machina Pilot Cities (trainers) and participants of the Academy. It features a collection of information gathered from the existing maker network with new contributions from the Pop-Machina consortium. The Handbook explains the vision and mission of Pop-Machina, including methodologies for making through collaborative production and design in a circular economy context. In addition to this, it illustrates the strategy and approach that will guide the trainers in the Pop-Machina Pilot Cities. Practical information regarding the makerspaces, the

[16] https://hackmd.io/
[17] https://about.gitlab.com/
[18] https://github.com/
[19] https://about.gitlab.com/

making library, toolkits, guides, and action research from the community are also included. The first section, Trainer Global Guide, is dedicated to the selected local Champions of the seven Pop-Machina Pilot Cities during their training together with Fab Lab Barcelona and IAAC.

Throughout the process they were able to use the guide as a reference for their assignments and key learnings. The second section, Local Training (Pilot Cities), can then be used by the local Champions after the completion of the training programme. The Local Training will provide information dedicated to each Pilot City's local context and can be used for creating Workshops for and with their respective communities.

The Pop-Machina Maker Academy Handbook is a collection of knowledge and tools. It extracts and merges the knowledge of an existing ecosystem of Fab Cities, Fab Labs and other exemplary institutions working to assist in the development of the Pop-Machina Maker Academy. The idea is that this handbook will contribute to engaging citizens to build circular maker communities in the seven Pop-Machina Pilot Cities. On a practical level, the information provided should serve as a guide for the local MCs throughout their training. After completion of the training programme, the local MCs and members of the circular maker clubs are invited to use this handbook as a reference. The Handbook is a living document and will be updated throughout the Pop-Machina life cycle. It is not a standalone resource. The Pop-Machina consortium will provide an online platform on which the members of the project can exchange their experiences. The local MCs are invited to contribute to the Gitbook and Github repository, which will enhance the content of this project. However, throughout the duration of the Academy, and with the development of the Open Knowledge Tool (OKT) in WP4, the documentation of the Academy content was revised. For this reason, the Gitbook or Pop-Machina Handbook will be transferred to the OKT only as soon as the platform is established.

Each Maker Champion was asked to document their personal journey throughout the PMA. In one of the initial sessions the MCs received an introduction to why documenting everything is important, which is explained in the following section. In addition to this we introduced Git, and Git repositories. The introduction included a brief explanation and how to make a website. However, the main objective was to share links to resources for the Champions themselves to learn by doing, by following a tutorial to make a personal website. This process of documentation on a webpage is common practice in many academies such as Fab Academy and Fabricademy. Making the progress public makes it accessible to the other MCs.

When it comes to documenting project work the most important aspect is that one is not writing a tutorial, a step by step guide, or telling others what to do. Through documentation, the MCs are able to tell a personal story: the journey of the learning process. While providing details about findings, they also have to become storytellers. Documentation is not about the final result – it's about the learning journey. What was the goal, what had to be researched, how was the solution approached, and what was the outcome? The documentation includes both failures and successes. There is a tendency to hide failures inherited from our educational system. In traditional education, failure is negative. But there is much more one can learn from documenting failures than merely documenting successes. The simplest explanation for documenting everything is that the recall memory of humans is similar to that of a goldfish. Normally people will remember less than 60% of something after just 20 minutes. Documentation happens throughout the whole project lifecycle.

What is the importance of documenting everything while working on projects?

1. If one is having trouble, it will help the local or remote colleague, a friend or the class to understand what was done
2. It helps your during research to keep track of what was done
3. It helps to acquire a good habit that is useful in the future, not only for PMA
4. It is telling a story, not a step by step tutorial. It is "what was done", not "what to do"

The essentials and principles of documenting are as follows:

1. Explaining with a personal perspective what was learned.
2. Detailing how it was learned, documenting the learning and making process.
3. Taking photos, notes and screenshots while working, compressing and resizing images for the web. Using these to explain and describe what was done e.g. a 'hero shot' is the best photo showing your finished project.
4. Reflecting on what was learned. Why is it important personally? How useful was it? How can it be useful to others?
5. Design files and code must be present in the archive in generically readable forms such as DXFs, STLs, etc., as well as in the original editable format (antimony, solidworks, eagle, CAD, etc).
6. Acknowledging work done by others paying attention to licenses for work used.
7. Abiding by the Commercial Board Policy

6.2 Content & Materials

The curriculum of the Academy is based on Fabacademany content, the Future Learning Unit approach, matched with the goals of the Pilot Cities. The city priorities were extracted from the city profiles and were systematized during the establishment of WP5. Together, these inputs formed the content and meta topics for each month of the PMA. Each meta topic uses a case study as narrative which exemplifies the narrative. Giving the case studies as an example breaks the meta topics into tangible actions. The actions help the MCs to understand how to address e.g. SDG's or city priorities. The participants were made part of the making process of the Academy. In practical terms this means that the MCs were asked by the end of each session if there were any specific questions or topics which should be addressed in future sessions. Furthermore, throughout the duration of the PMA, it made sense to have collaborative sessions with other work packages and task leaders from the consortium which directly influence the future of the Circular Maker Space (CMS), or have valuable information which can be shared with the MCs. In summary, the 17 sessions had eleven guest speakers, eight of which were directly from the Fab Lab Network, and two from the Pop-Machina consortium.

For the CMS three main categories were identified which should be addressed in the curriculum: 'community', 'tech' and 'business'. In the CMS everything is about the people, and how the people together create communities. The communities make the CMS thrive and grow. Technologie is a driver for the communities. It may serve as a building block for creating maker clubs around topics of interest, or for pushing forward innovation. Business is crucial for the sustainability of projects developed in the CMS, as

well as for CMS itself. All categories together cover the inputs necessary for the CMS's needs. However, it is not always that they can be clearly distinguished from one another. Many of the talks and interactive sections of the sessions drive toward linking the different categories. A reflection based on this will be further discussed in section 8. "Final Considerations".

In May 2020 an introductory document was sent out to all the MCs in advance of the kick-off session. This document included the objective of the PMA as well as the overview for the following months. Additionally, the agenda for the first session was included. The reasoning for this is to not only give the MCs a holistic overview of what the upcoming months will look like, but also to ensure that everyone is on the same page when starting the Academy. The agenda included the names of all participants as well as the links for the most commonly used tools. The document can be found at the Pop-Machina Academy website[20].

Based on the PMA curriculum and calendar, each session is structured as following: (1) Introduction and welcome, (2) Inspirational talk incl. Q&A, (3) Break, (4) Interactive section including "show and tell" and ends with an (5) assignment for the week.

(1) The introduction and welcoming to the session were kept informal. Most of the time the participants need two to five minutes to join the online session; hence the first five minutes of each session are reserved for quick check-ins with the MCs.
(2) The people who were invited are from the different existing communities from the Fab Lab Network and Maker Movement. Each one of them brings a unique point of view and perspective based on hands-on experience. After the talk the MCs have the possibility to ask the guest speakers questions.
(3) A break before transitioning to the interactive section helps the mind to retain information. Due to the length of two hours of each PMA session, it makes sense to take a break so the participants are able to concentrate on the content that follows.
(4) The interactive sessions are mainly facilitated by the Fab Lab Barcelona team. However, the possibility for the guest speakers to interact with the MCs during the interactive section was provided. The interactive sections of the Academy follow the priors explained learning methodologies and directly connect them with the MCs' practical experiences. Some had a stronger focus on the building of the Circular Maker Community with our participants e.g. session 10. Others more directly put the learnings, such as technical know-how, into practice e.g. the IoT activity workshop in session 11.
(5) Finally, the sessions were summed up, with an explanation of the assignment for the following week. Some assignments which asked the MCs to 'make things' were more time-intensive, such as the moulding and casting assignment. Mainly the assignments were dedicated to the documentation learnings and reflection on each session. *

[20] http://pop-machina.eu/academy

6.3 Session's timeline

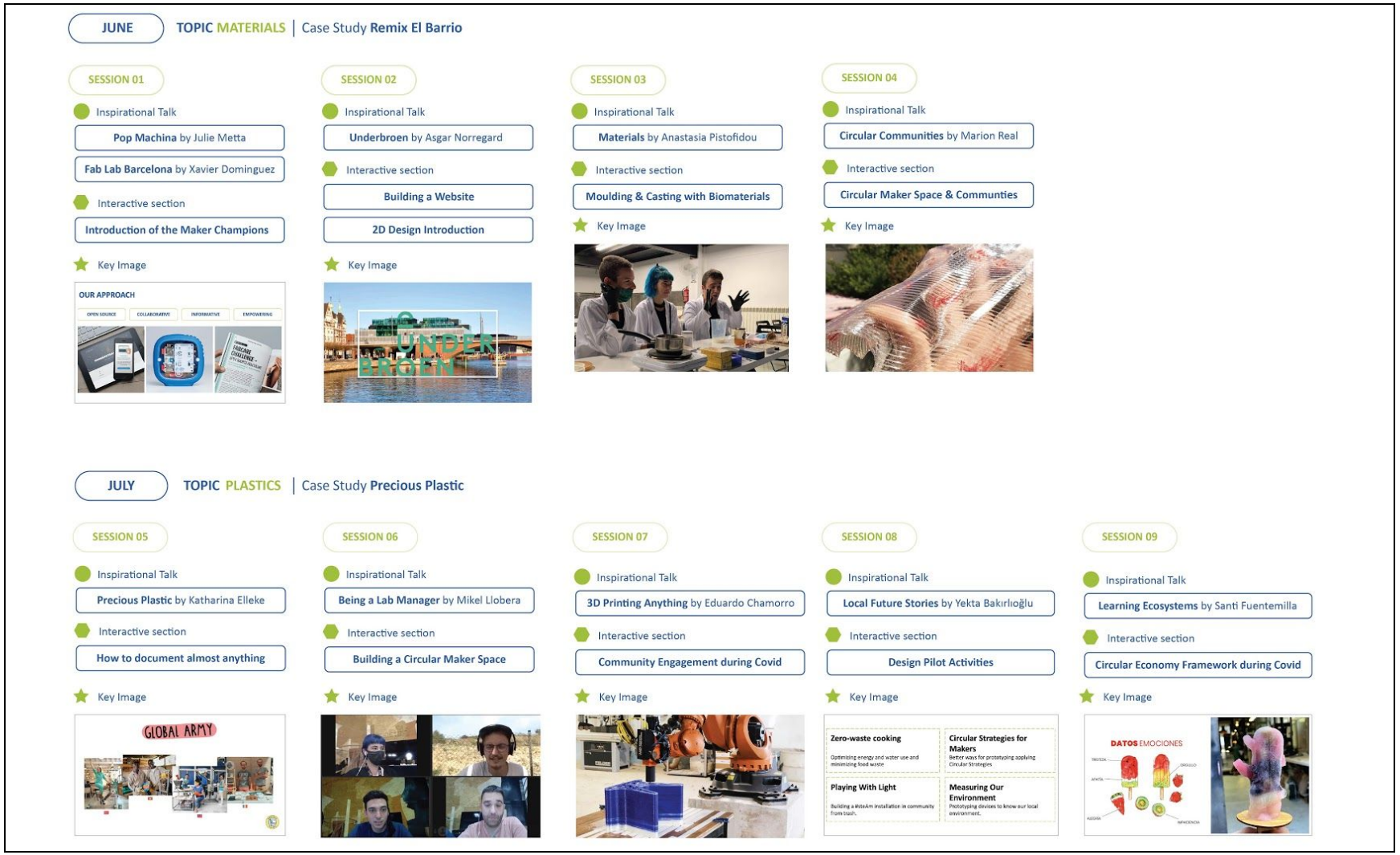

Figure 16 'Pop-Machina Academy Session Timeline 1'

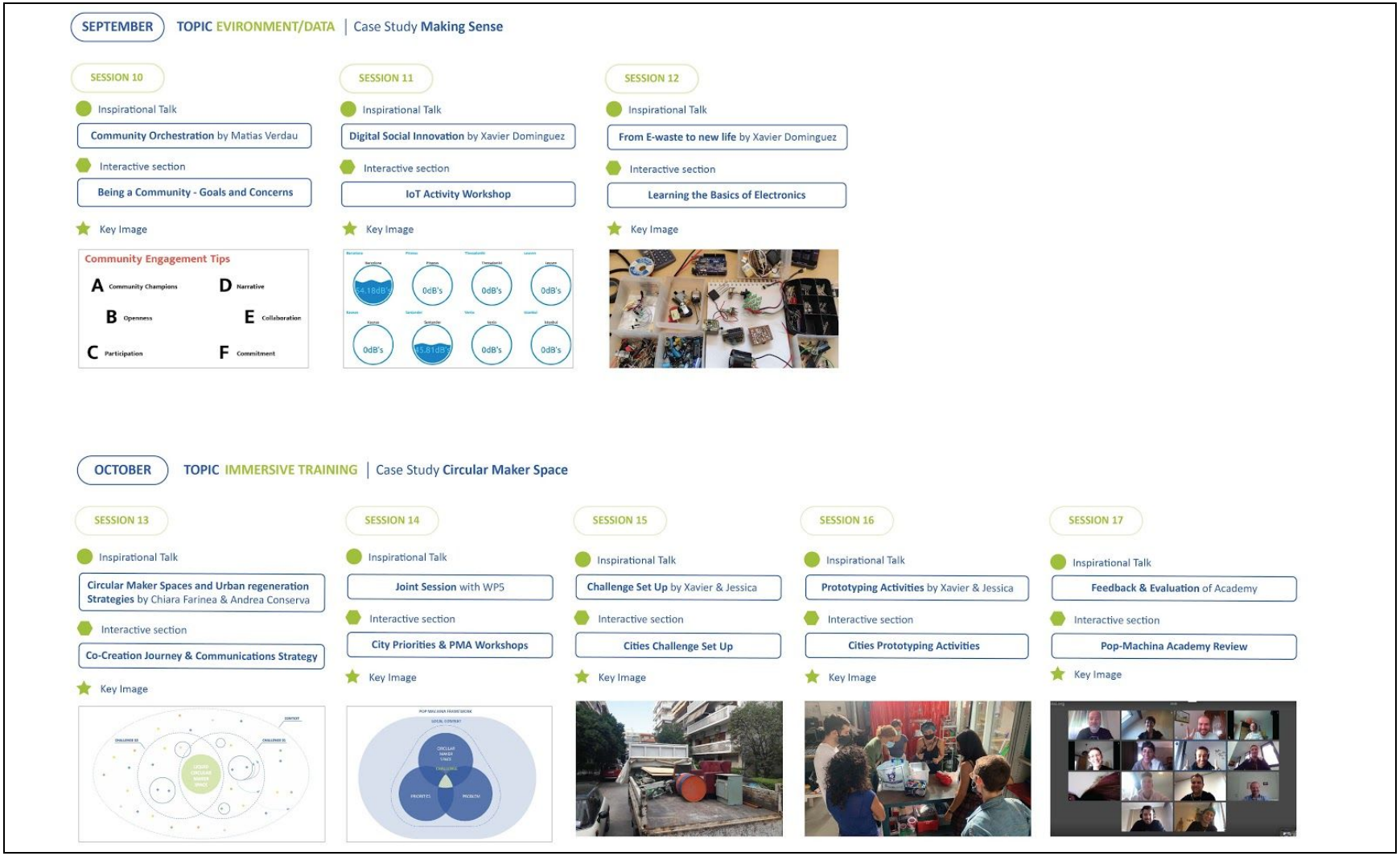

Figure 17 'Pop-Machina Academy Session Timeline 2'

Pop-Machina Academy in June

Building a community of Circular Maker Champions is the starting point of the Academy. Hence the interactions of the first sessions were with a strong focus on getting to know each other. Through informal conversations, bringing in this 'human' aspect supports the building of trust and belonging in a community. The month of June was dedicated to the meta topic "materials". Materials are what the world is made of, the base and beginning of every project. In the PMA we challenge what is understood as materials. Material is commonly used in language as a synonym for "raw materials", such as but not limited to wood, metal, plastic etc.. In a circular economy the usage of raw materials has to be questioned. Therefore, in the PMA conversation on the reuse of materials, the making of (bio)materials and the unpacking of the term "waste" were initiated.

The case study 'Remix El Barrio' relates to the topic 'materials'. Remix El Barrio is the Barcelona pilot of the H2020 SISCODE project. Remix El Barrio is a local co-creation project which rethinks food surpluses and waste. The designers of the project propose projects made from food leftovers using artisan techniques combined with digital fabrication. In collaboration with stakeholders in the neighborhood of Poblenou, Barcelona, they promote a shift of the local ecosystem towards a circular economy. This group of people imagines new models and techniques to innovate what is commonly called "waste". They affirm the potential of co-design, and their innovative yet artistic practices are inspiring drivers for societal change. Circularity is not only expressed through their usage and application of materials such as olive and avocado pits but also through their way of working. They are exploring collaborative design with local actors, sharing knowledge and including principles such as inclusiveness and self-management.

Pop-Machina Academy in July

The month of July is dedicated to the meta topic "plastic". In recent years we have seen a global trend of initiatives to reduce, reuse and recycle material waste, supporting the decrease of linear production life-cycles and transforming them into circular means of making. Such practices can be seen in citizen-driven "grassroots" initiatives, one example of which is Precious Plastic. Fab Labs, makerspaces and other spaces for collaborative making are starting to implement more holistic practices. Repair Cafes and shared workshops dedicated to recycling and upcycling have been able to showcase their implementation in community spaces.

The case study for the month of June was Precious Plastic. Precious Plastic was initiated by Dave Hakkens in the year 2012 as a graduation project at the Design University of Eindhoven (Hakkens October, 2017). He was aware of the limited percentage of plastic being recycled. His aim was to build small-scale recycling machines for plastic to distribute to citizens, to empower them to participate in the recycling process on a local level. All designs and blueprints of his work are shared online, open-source, and for free. Over the years the team behind Precious Plastic has grown and, with that, the global recognition of their work. Many iterations and adaptations of the machines have led to Precious Plastic Version 4 which not only includes the technical aspects of the Precious Plastic machines, but also guides users in collection, sorting, alternatives to plastic, and community engagement.

Today, many people are inspired by this project. Over 80.000 people, globally, have "risen their hand" to commit to participating in the global movement of reducing plastic waste, thereby contributing collaboratively to the development of Precious Plastic (Precious Plastic, n.d.). TThis project was not only able to share

knowledge, raise awareness, and build capacity, but also empowered people to act as nodes for distribution and amplification (Hakkens October, 2017).

However, until today, the holistic implementation of such projects in Fab Labs and makerspaces is limited. Material flows of subtractive making processes present challenges for makers to fully embrace circular means of production. The makerspaces often lack the systematic implementation of proper sorting techniques for the many different materials used, or they lack the capacity and resources to apply them. Needless to say, there is the ambition within the maker movement to improve the transition to more CMS. More information about the Precious Plastic case study can be found in the annex.

Pop-Machina Academy in September

The month of September is dedicated to the meta topic "Environment and Data". For citizens, environmental data has been kept behind locked doors for a long time. Only people considered experts are exposed to data and decision making processes. However, this discrepancy supports top-down policy making, and often leaves important topics neglected. Who if not the citizens themselves, being in direct contact with the issues, should be taken into consideration when making decisions? Nowadays, many of a city's inhabitants are interested in understanding the substantial issues that their city faces. Engagement emerges not only from interest of understanding, but also from a mutual concern. Shaping the future of cities should not only be left to politicians and scientists, but by all people living and working in the city. Through this more holistic action, plans can be shaped. In recent years there has been an increase of bottom-up initiatives in the maker movement which propose change through taking action. This fundamental development can support local and global goals to transition to more sustainable and circular means.

The H2020 project Making Sense aims to explore participatory sensing through open source software and hardware, making digital maker practices and design available for citizens. Through this, communities and citizens can fabricate their own sensing tools, making sense of environmental concerns such as air, water, soil and sound pollution. The aim is that citizens become agents of change with the capability of partaking in policy making. The pilot located in Barcelona has focused on a vibrant area in the neighbourhood of Gracia. Located at its heart is Plaça de Sol, a town square which is dedicated to gathering and socializing. Unfortunately, the place is also known for its high noise level; hence the local residents often complain. Collaboratively, residents, volunteers and the Making Sense team from Barcelona have investigated how to improve the situation. Together they have mapped the problem, set a strategy, and shared knowledge in the form of learned technical skills. The project serves as a great inspiration and is the leading influence – together with the SISCODE project – on how Fab Lab Barcelona approaches community engagement and community building activities. In the context of the PMA, we utilize the Making Sense approach not only in terms of technology, but also in terms of how technology, together with a set of activities, can foster community building.

Pop-Machina Academy in October

The month of October is dedicated to the Immersive Training and "Challenge Set Up". The immersive training during the PMA does not only offer more technical knowledge (the workshop facilitation canvas and

communication strategies), but contextualizes the addressing of local challenges. The previously mentioned skills are merely part of a framework which supports the co-creation journey of the Liquid Circular Maker Space (LCMS). For this co-creation journey the Maker Champions have to understand how to set up local challenges. Firstly they will (1) analyze the context, then (2) frame the challenge, to finally (3) prototype activities. All of this is in iterative processes, and follows the learning-by-doing methodology.

(1) Analysing the context

To understand the context based on experience or by analysing the situation, or to re-interpret an existing problem (a). To identify how differences in circumstances of the environment are related to the project/challenge. For this we have shared a tool with the MCs which helps to define a problem to set up a challenge (b).

(a) Defining a problem is an important step to creating an effective and efficient solution, as what may have at first appeared to be the problem may just be the result of an underlying larger issue. This tool allows groups to understand what these underlying factors may be, and to contextualize the problem so as to re-frame it in a more specific and direct manner.

(b) The tool can be filled in individually or in groups. Working on the task in groups is preferable, as the objective of the exercise is to approach the problem from different viewpoints in order to better understand and define the problem. Including stakeholders in the process is another useful idea. The worksheet should be filled out from left to right.

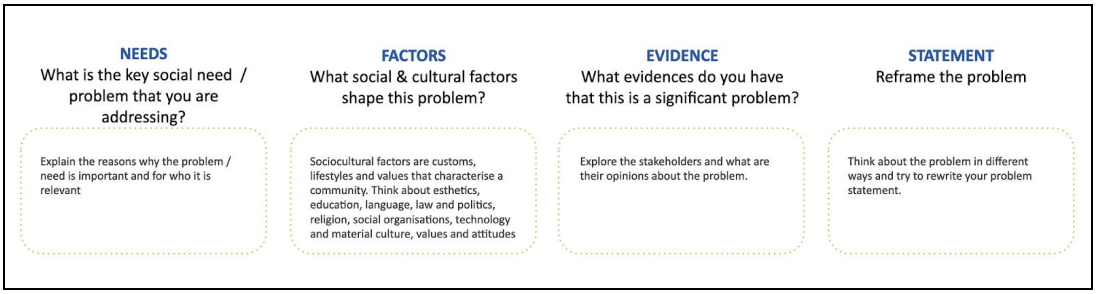

Figure 18 'Pop-Machina Academy Problem Definition'

(2) Framing the Challenge

The local challenge or challenges is a long term framework for the CMS. The challenge is situated in your local context and aims to support the city goals by rethinking how we do things and how we can address problems through the means of making in a collaborative manner. The challenge is defined by the existing local limitations in the CMS, the city priorities, and local problems.

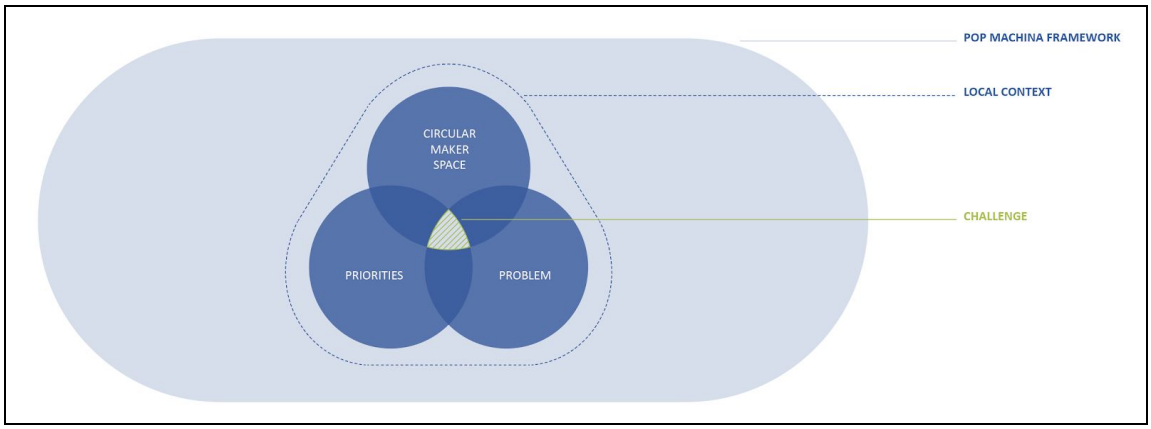

Figure 19 'Pop-Machina Academy Challenge Setup'

- Limitations of the CMS are the capacity of the team, existing technology and skills.
- The limitation of the city priorities streamline the focus of work.
- Limitations identified while defining a problem are key special needs, social and cultural factors, evidence, and a statement supporting the framing of the problem.

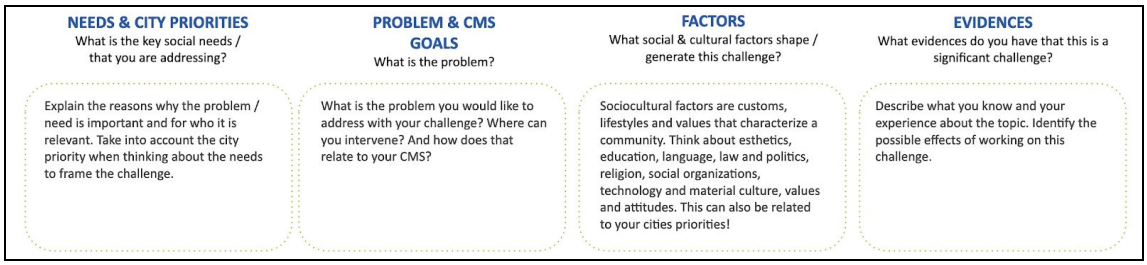

Figure 20 'Pop-Machina Academy Challenge Setup: The context'

The canvas is based on and adapted from the Co-creation journey provided in the SISCODE toolbox and supports the MCs to make sense of the various factors which influence the local context. During session 13 the Champions were guided through the processes of filling in this canvas – more information about this can be found later in this report in section "Session 13". In the same session a canvas to identify the CMS capabilities was shared.

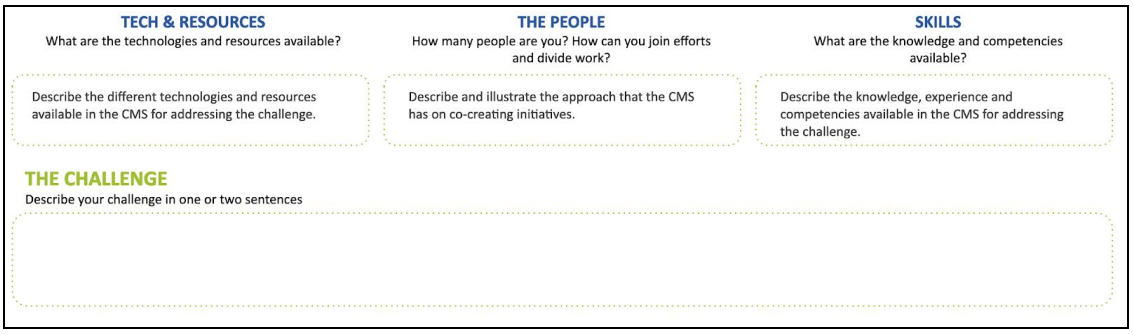

Figure 21 'Pop-Machina Academy Challenge Setup: The CMS capabilities'

(3) Prototyping activities

The activities are short and iterative, and come in the form of workshops, webinars, stakeholder engagement, etc. It applies new visions, ensuring that the solutions are purposefully built around people's experiences and skills, and can provide real value. In summary the steps for the CMS or the Maker Champions are as follows.

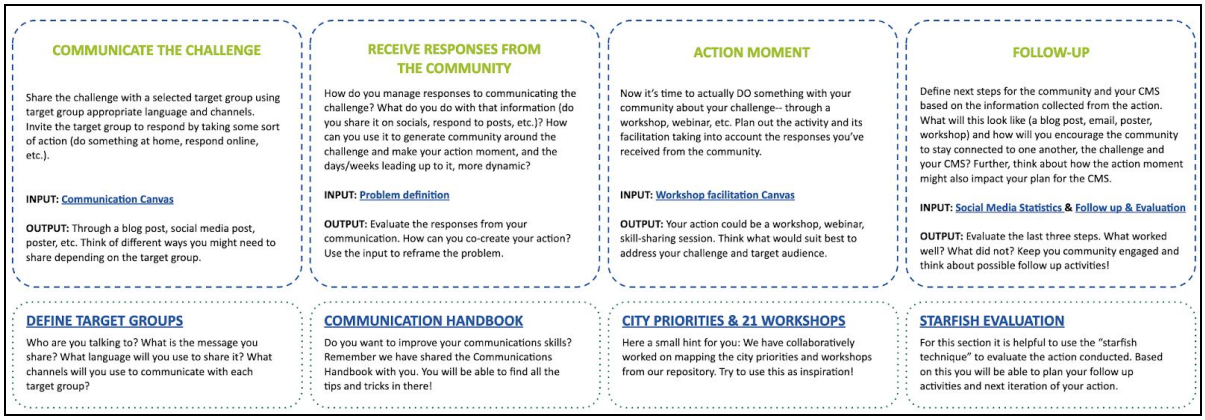

Figure 22 'Pop-Machina Academy Four Steps for Challenge Activities'

The workshop facilitation canvas is common practice for any activity conducted in Fab Lab Barcelona. The canvas was used internally for the duration of the PMA, and for the planning of each interactive session; hence the canvas was also shared with the Maker Champions from early stages in the Academy to enable them to put this into practice while still attending the PMA.

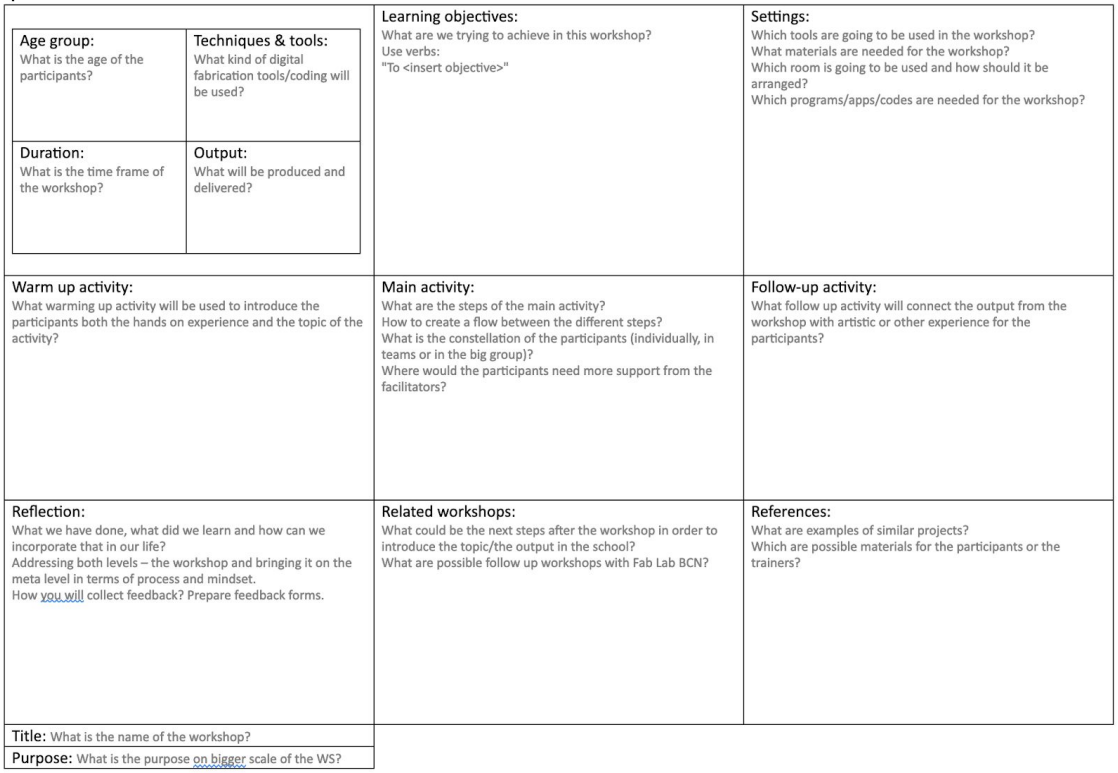

Figure 23 'Pop-Machina Academy Prototyping Activities: Workshop Facilitation Canvas'

(4) Evaluating outcomes

Feedback and evaluation mechanisms are very important for the iteration processes of your activities and challenges. The insights gathered will help participants to question, reframe, adapt and learn while staying agile. This is important for personal learning, CMS and community development. Through constant feedback loops, the evaluations help to frame the new iterations of actions. The tool, which was shared with the Champions, can be filled in individually or in groups. Use the "Embed feedback" page to: Identify the hypothesis (what one is looking to learn) for the prototype, and the evidence needed to validate that. Then, the Champions can write down how they plan to capture that data – this could be e.g. through surveys or interviews.

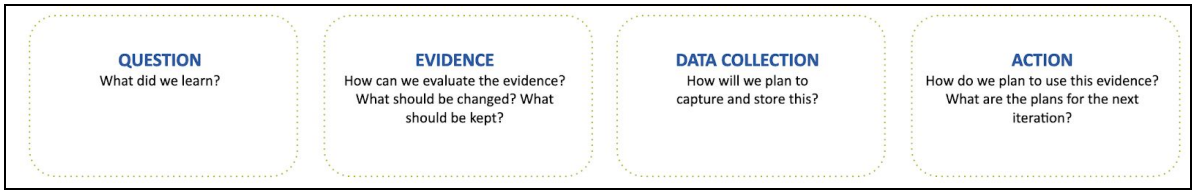

Figure 24 'Pop-Machina Academy Evaluating Outcomes'

Stakeholders Engagement

The successful implementation of activities in the CMS is also dependent on communication strategy. The communications handbook is a tool developed by Fab Lab Barcelona. The communication strategy helps to engage stakeholders, and communicate the project to different audiences. In session 2 the Champions were already engaged to create the basis of their CMS brand narrative through the making of a 2D design of their CMS logo. The communications handbook was shared at the same moment. However, there was no dedicated session until the immersive training. That being said, the handbook was at the disposal of the Champions for the entire time. Finally, during the immersive training, the remaining content of the supporting materials was connected to the challenge setup.

Visual narrative and identity are at the core of this strategy. The description of motivations or projects using topics, values or themes assists to tell a story for local and global audiences. Key messages are the core messages which attract the audience's attention and help them to remember the contest side to the project. Key words are the distillation of the project's essence. Using the same keywords over the duration of the project's life-cycle communicates the vision and mission of the CMS in a consistent manner.

After agreeing on the narrative, the identification of the target audience shapes the use of language. Depending on the people one is addressing, the reasons why they are interested in the project might be different– hence they receive and understand information in different ways, be they stakeholders, organisations or general public. The communication and language used has to be chosen wisely depending on these factors. Presented in diverse ways, the projects, or CMS's campaign, can successfully reach the target audience. To synthesize the above-mentioned approach, a communication canvas for stakeholder engagement can be used.

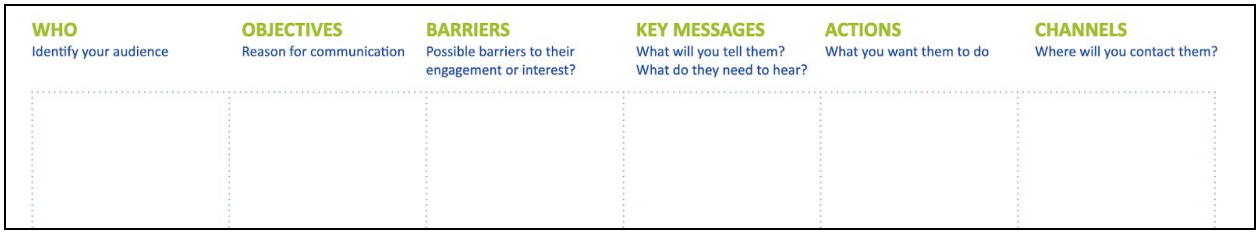

Figure 25 'Communications Canvas for Stakeholder Engagement'

In summary, the Academy focused on building capacity, key making skills, and building a community of Circular Maker Champions among the participants. During the month of October the focus shifted directly towards **how to set up and address a local challenge, together with the city teams**. It featured a canvas to co-design a challenge, the communications handbook, references, tips on how to document the process and evaluation methods. The Maker Champions set up their local challenge by following the Co-Creation Journey canvas which includes its four main steps: analysing the context, framing the challenge, prototyping activities, and evaluating outcomes.

The Maker Champions entered the instructional phase of the Academy during the Immersive Training. The role of Fab Lab Barcelona has shifted – in practical terms this means that we as facilitators only provide materials, and the MCs are encouraged to work more autonomously. They were asked to set up a realistic challenge for the following three weeks in session 14. Session 13, which took place one week before, already briefly introduced this idea to the Champions, which gave them the opportunity to brainstorm ideas beforehand. The communication strategy in session 13 also served as preparation in this process. During the PMA sessions they were provided all necessary materials and support to do so. During the week they were then encouraged to execute their plans. Throughout the whole process we offered support via Slack, in case there were any issues encountered. More information about this can be found in sessions 14, 15 and 16.

6.4 Technical Content

The focus of the PMA was truly the community building aspect which we have emphasized in the past chapters. The technical content on 'how to do things', 'how to use machines' and 'how to learn new software' already exists in the Fab Lab Network and the maker movement. All this information can be found in existing academies, online platforms or simply on YouTube. What the participants of the PMA have learned was (1) to learn how to learn, and where to find information in existing networks and platform ecosystems; (2) how to add the layer of circularity in a makerspace; and, finally and most importantly, how important the 'human aspect' in relation to, and in interconnectivity with, others and our environment is. This leads to (3) how to build and sustain Circular Maker Communities. Because – and we have mentioned this previously – the people in the space make everything possible.

Fabacademany

All technical information in terms of project management; version control; computer-aided design; computer-controlled cutting; design thinking; electronics production; 3D scanning and printing; electronics production; computer-controlled machining; embedded programming; input and output devices; interface and application programming; invention, intellectual property, and income; networking and communications; moulding and casting; mechanical design and machine design, can be found at The Fab Academy. The

content is online, free and available for self-learning. However getting access to the Fab Labs' inventory and staff, and getting feedback and guidance from Neil Gershenfield is only available when officially taking part and paying for the Fab Academy programme. Through successfully graduating from the programme, the participants are officially eligible to open a Fab Lab.

Workshops

The 21 Workshops are provided by Fab Lab Barcelona. This workshop repository provides all necessary content, instructions and guidance for the MCs to use as community building activities in the CMS. The workshops are not mandatory for anyone to use, nor should they be seen as static documents. The 21 Workshops are merely a starting point and inspiration for the MCs, cities and anyone interested. They are open to be adapted to the local context if necessary. The Open Knowledge Tool, which is part of the Pop-Machina platform, will be hosting this information.

CMS Inventory

The inventory for the CMS is based on the inventories of Fab Labs. Once again, these inventories should be seen as inspiration and guidance for the cities, city partners and MCs to support the deployment of the CMS and pilot. The inventory was shared during the PMA. The documents, which come in forms of simple Excel sheets, are living documents, and are open to remixing and adaptation. Based on the local context and work done together with WP5 the pilots and CMS can pick and choose which equipment fits their needs. Eventually, after receiving the feedback from each CMS, a first evaluation of what a CMS inventory consists of can be made. However, over the pilot lifespan, this inventory might change or grow. Monitoring and reflecting on this change can make sense.

Interview with Jordi Reynes from Ateneus de Fabricació

During the PMA Xavier conducted an interview with Jordi Reynes. In the past Jordi, with the help of Fab Lab Barcelona, set up a space which is called Ataneus de Fabricació, which is basically a makerspace with digital fabrication tools. There are multiple Ateneus in Barcelona, all being managed by the municipality and people directly working for them. The interview was conducted to get insights on the perspective of someone from the municipality who has set up a makerspace. The aim of this interview was to support the MCs who also work for the municipality. Before the interview took place the MCs were able to share their questions and concerns with Xavier. Xavier was able to synthesize the questions with the entirety of the information at his disposal. Unfortunately, Jordidid not attend one of the PMA sessions because he doesn't speak English. Xavier took the time to interview him, translate the interview, and make the content accessible for all MCs.

Precious Plastic

During the PMA it became clear that many cities are interested in setting up a Precious Plastic recycling or machine workshop in the CMS. Hence, it made sense to have an open session with Katharina Elleke. She was so kind as to not only introduce Precious Plastic in more detail,but to answer all of our questions as well, and to bring together all necessary information for the MCs' successful implementation of it in the CMS. To set up a Precious Plastic space one has to understand the capacity, resources and limitations of the CMS and, based on these inputs, the vision for feasible implementation. However, to ensure the space reflects the community's needs, it should stay flexible by nature, and be continuously evaluated for any necessary

adaptations to be made. This may be reflected in the layout of the physical space, the activities conducted, processes added, or general management of the space.

The capacity of the CMS is defined by, as mentioned previously, the people involved. It is important to have a team with dedicated roles, and time available. These people may or may not have existing knowledge about the Precious Plastic project in general. Nevertheless, necessary knowledge and skills may be gained over time if the profile of people involved shows a willingness to learn, which may also be called a "maker attitude". Over time, this capacity can change. Furthermore, through involving and empowering the people who will work and use the Precious Plastic space, a sense of responsibility may be formed. Sense of belonging and responsibility can ensure that the initiative's life-cycle is long-lasting.

There are resources in terms of people, time, materials, machines, architectural space available and possible financial resources. Achievable goals can be set through understanding the resources available and sharing them openly with the people involved. It makes sense to understand the limitations of the space. These can be understood by analysing the capacity and resources available. The limitations should not create a sense of restriction, but rather a framework for work. However, limitations can be overcome with time and dedication from the team. Through initiatives such as Precious Plastic, citizens are empowered to intervene in this outdated status quo. The synchronous and asynchronous 'glocal' approach may support this needed shift. All experiences with the materials and innovations made can be documented and shared for replication and iteration. The awareness and call for participation happen not only globally but also locally. Through short term goals and local actions, makerspaces can contribute to a change in practice, despite the fact that the global long-term vision is to not use natural resources in such a wasteful manner in the first place. Instead of producing more plastic, the focus is rather to step into the material/waste streams, reusing existing material through recycling and creating more meaningful and long-lasting products. The glocally shared knowledge surrounding the topic of plastic contributes to the impact of recycling and manufacturing processes in spaces not only dedicated to making.

The detailed content which was provided to the MCs as to the technical content from Fabacademanies, the 21 Workshops, the CMS Inventory, and the what and how of Precious Plastic workspace setup in CMS, can be found in the annex.

7. WHERE: Makerspaces and Pilot Cities

Within the project's seven Pilot Cities, trainers will engage with their local communities in a collaborative effort for implementing new strategies and approaches towards circular ecosystems. The solutions are based on digital fabrication combined with traditional making practices. For further understanding the approach co-created for each pilot city, see appendix 06. It offers an overview of each Circular Maker Space (CMS), the Maker Champions (MCs) and the challenges during the immersive training month of October. The CMS was designed during the pilot deployment to understand personal priorities and goals. As planning for the CMS commenced simultaneously to the PMA, we will briefly elaborate on the city priorities and goals for each CMS. This is important for the facilitators to ensure Academy content is audience-appropriate and useful for MCs and CMS. To build on this content, we collaborated with WP5 to add necessary content to the

Academy, such as: the MCs point of view of what a community is and how to engage people into participating in circular maker communities. Inputs for the CMS goals, community engagement and challenge set-up from the MCs are contextualized in this section.

8. Final Considerations

The deliverable 3.4 focuses on the Pop-Machina training programme and building circular maker capacity through training. The training programme was based on an action research methodology. Throughout the whole duration of the Pop-Machina Academy (PMA), we have documented the voices of the consortium members, guest speakers and Maker Champions (MCs). Our aim in applying this methodology is for providing agency and empowerment for all the participants. The training programme was designed collaboratively. In other words, it was co-design and co-created. This report includes the context of the Academy, method, curricula and tangible outcomes. Our aim was to create knowledge and distribute this through the Academy. We would like this to be useful for the MCs and the set up of the CMS (CMS). Based on our critical reflection on objectives, methodology, and results; we claim future studies would be desirable for enriching the research scope with the goal to better understand the maker communities functioning, the types of people the Academy may target for future iterations for the training programmes, the communities needs, how can we look at potential members who are struggling with access to makerspaces because they lack the skills. The limitations to the methodology were mainly related to access to real data and time constraints due to the online format.

Through the Academy, we connected with the MCs on a personal level, where we felt they were recognised and represented at the very core of our work.. This is a means for social justice. The MCs will be the future trainers and facilitators in the Pop-Machina makerspaces, empowering proactive communities. The MCs are at the very forefront of our mission; working locally with people and supporting the dissemination of Pop-Machina research. This connection to the people and local fabric aims to achieve the goals of the programme. We believe a successful research project integrates academic research into real-life context. This has occurred in our pilots over the past months. Our work is people-centred with a holistic approach that acknowledges the interconnectedness of the environment. This report is a comprehensive summary of the past six months of collaboration. We are very satisfied with it and would like to see our progress flourish. Despite the ending of the Academy the establishment of the CMSs has only just begun. The Pop-Machina consortium can benefit from finding ways to recognise the MCs as a driving force for the project outcomes. This holds the potential to change many lives.

The collaboration with other work packages, e.g. WP5 and WP2, has shown that alignment of workflows are not only useful for consortium members, but also for the MCs We have worked transparently, fostering a relationship between MCs, municipalities, the Academy, makerspace and pilots. We were able to identify valuable content from the consortium and include it in the Academy. For example, the training to understand material flow analysis is a good illustration of knowledge that is useful for the CMS. This kind of technical and context-based research approach is beneficial for Academy posterity. Therefore, we would like to suggest for future iterations of the Academy within similar projects. The collaborative approach of the PMA should be incorporated into CMS to contribute towards the improvement of the maker community.

The outcomes of the PMA to be successfully included in the social collaboration platform for the Open Knowledge Tool (OKT). The OKT serves as a tool for collaborative learning and making, including the curricula and the21 workshops for the MCs. These tools are living documents that will be updated by consortium partners, MCs and other participants, throughout the Pop-Machina project. We hope to positively influence the consortium and a range of stakeholders to embrace the open-source mentality in which content is created, shared, adapted, remixed and reshared. This is a fundamental assumption within the maker movement. Even though the COVID-19 pandemic changed many aspects of the PMA the overall outcomes are positive. It was a challenge to build community without being able to physically share our experiences. Nevertheless, we made it possible. We see the Academy as a success due to the reported sense of community between the MCs.ç

8.1 The dream: future iterations

The Pop Machina Circular Maker Academy is an innovative programme. We like to call it "a dream". The first step for our dream to come true is our learning-by-doing based model. The PMA setup was a testbed for a new format for Fab Labs to deliver their Academies. The first iteration aimed to explore how makerspaces can tackle a transition towards more regenerative ecosystems. There were two important concepts in the Academy:: *circularity* (in particular, the circular economy) and the second is *collaboration* (collaborative production). We assume the following step for our dream to "become reality" is to find ways to support the sustainability of the PMAs. The Institute for Advanced Architecture of Catalonia (IAAC) and Fab Lab Barcelona arecommitted to the emergence of new iterations of the Academy. For future iterations, we believe it is crucial to keep collaborating as a community, co-designing altogether with the Circular Maker Champions Community (or simply "CMC") what we aim for the PMA to *become* (or to keep "becoming"). In practical terms, we have planned meetings periodically (monthly or bi-monthly) with the emergent CMC community for peer-to-peer support. This will serve to share knowledge between emergent CMSs practices. Furthermore, these meetings aim to create a ritual and "space" in which any potential Circular Maker Champion (CMC) will be able to join the "niche" community (part of the Maker Movement). We would be glad to bring this the mainstream across all the members of the Maker Movement. More specifically, we expect for the PMA future learnings to serve as a "platform" for shared learning, as stated in the Fab Cities full stack approach. The materials that will be generated within Pop-Machina in the next two years are expected to be incorporated as new content for the PMA. For example, a common CMS inventory, bill of materials and the usage and integration of this, is currently being developed by Tanya Tsui at TU Delft and the WP4 team. This will become part of the future sessions.

PMA was designed for makers. We would like to reinforce the idea that "*we are all makers*". Literally everyone can become a circular maker champion. The more CMCs we have, the more our collective sustainability efforts can resist. Let's not forget what was once thoughtfully stated by Cindy Kohtala and the notion of fabricating resilience. We believe CMCs are the driving force for the transformation the Maker Movement holds the potential to do. PMA was designed and structured in a format that could be deployed to *any* citizen and immigrant. Regardless of the alternative designs "shape", both methodology and practices can be adapted to benefit diversity, plurality and inclusivity. Our dream for future generations is to offer PMAs (and multiple iterations of it) to the wider public. We can teach the processes and related content to different target groups.

For instance, if applied to a K12 formal and/or informal education, an adapted PMA methodology may work.That is because of the liquid aspect of the PMA. A brief recap: *Why* is it liquid? It is because it is based on people and interests, and these change and evolve over time. "*The LCMS takes on the shape of the community, reinventing itself through iterative and agile cycles by continuously evaluating its needs in function of its community. This may mean adapting everything from the LCMS´s physical layout to how it is governed and used"* (semi-structured interview, Xavier Domínguez, 2020).

The concept of "Liquid" is largely used in education as a variant of "liquid modernity" (Bauman, 2000). To our best knowledge, this is the first time it has been applied to the Maker Movement. PMA is already an iteration of the Fab Academy. Its foundations are deeply embedded with the notion of openness and sharing societies. PMA was built from the shared repository and content accessed by passionate persistence learners and tutors, such as the inspiring Santi Fuentemilla, Xavier Domínguez, Jessica Guy and all the makers at Fab Lab Barcelona and beyond who have contributed to this dream over the past year. The PMA makes sense in the context of Fab Lab Barcelona. There is a vivid philosophy behind it. PMA reflects Fab Lab Barcelona's team learnings. We are constantly transforming ourselves as humans and our emancipatory consciousness reflects on the betterment of our makerspace. We believe Fab Lab Barcelona is like a magnet in our local environment and the energetic local communities inspire us so much. It might be the brilliant creative talents at Fab Lab Barcelona, our history and foundations, or our favorable context that combined are enabling us to transition to a Liquid Circular Maker Space (LCMS).

8.2 Practical considerations

There are some practical considerations about how others could use this report and method in their context, for example, a smaller community in size, a more nascent Fab Lab, within or not directly related to the Pop Machina project confines. At Fab Lab Barcelona, we have actively been seeking for meaning and purposeful work, which has brought all us together as a community. We share a vision to which we are all contributing on a daily basis. It takes effort, patience and care. Our active everyday practice empowers our self and organisational development. Our team in turn embraces the idea of empowering the so-called "champions" we are lucky to identify on the way: our wider community. People change, communities change, spaces change. PMA aims to make this change for the better enabling the emergence of more Liquid Circular Maker Space (LCMS). Are you willing to join us on this journey? Fingers crossed. In case you would like to engage on this journey, you may find useful information in our manifesto for the emergence of the LCMS in the following session.

The Liquid Circular Maker Manifesto

by Xavier Dominguez, Alessandra Schmidt, Jessica Guy & Sally Bourdon

We claim for a community hub to re-think the maker movement status quo, develop skills and competencies to make the transition to a circular citizen and generate opportunities for innovative business models. With the past 20 months of designing and implementing the Pop-Machina Academy (PMA) in mind, the potential for combining the concepts of 'circular economies and 'collaborative production' seem obvious. The congruence of these ideas will allow us to better deliver a more complete training programme. But can also be seen as a potential shift for the entire maker movement; allowing it to more actively engage with sustainability efforts. Pluralism, inclusivity and equity are at the core of our interest. The PMA provides the foundation for the emergence of a Liquid Circular Maker Space (LCMS). As a concept, the LCMS is a site where circular and equitable solutions to complex problems can develop, mature and scale. The space, its community makers and their innovations strive to re-define how society has operated for generations since the industrial revolution by actively prioritising the creation of positive social and environmental impacts. To do so, LCMSs collect, learn from and create global knowledge that can be adapted for local solutions. The physical space may be complimented by a digital sister platform. This online platform offers support through sharing data to identify resources in terms of materials, machines or people which can contribute to collaborative manufacturing processes (Pavlopoulou, 2020). The strategy for a LCMS is based on a fluid exchange of knowledge between bottom-up and top-down initiatives which includes a stakeholder network and local communities action. With the potential that these networks could lead to the creation of communities in and around the LCMS itself. The use of co-design or co-creation processes and approaches in the public realm supports public policy making by examining the emergence of a design practice based on prototyping methodologies (Kimbell & Bailey, 2017). Strong bonds can be fostered through a common agenda, shared measurement, community reinforcement activities and continuous communication. The emphasis is on distributed decision making which enhances agency throughout the community members (Splansky et al. , n.d.). The collaboration between the actors strengthens the foundation of the participatory ecosystem by bringing together different types of knowledge and expertise (De Koning et al. , 2019) The coalition can be described as collaborative by nature, as each actor of the ecosystem is sharing the same, or similar values, which is crucial for the realisation of the project. This allows the different actors to learn from each other, and collectively fabricate a canvas which builds the common ground for the participatory ecosystem. The terminology is better understood when contrasting it with the definition of what a makerspace is (see more details in the "background" session). The co-creation of CMSs and transition towards LCMS's are explained in the following chapters. In the context of Pop-Machina, we have explored the emergence of *how to co-create* a LCMS. The LCMS manifesto with background, principles and definitions are shared in 5.0 Theory and Results.

More than a space

The space, its community makers and their innovations strive to re-define how society has operated for generations since the industrial revolution by actively prioritising the creation of positive social and environmental impacts. To do so, LCMSs collect, learn from and create global knowledge that can be adapted for local solutions. To create this new paradigm, a LCMS cannot function in the same way as the current makerspace status quo: a space with machines, composed of a predominantly white, male, able-bodied,

middle and upper class community. Instead, the LCMS is an ecosystem. In nature, an ecosystem consists of a diversity of organisms, each of which carry out specific functions necessary for the ecosystem as a whole to survive. In natural ecosystems, the physical characteristics of a space itself combined with the variety of actors living in symbiosis with one another enables everything the ecosystem needs to be produced right there. In these natural systems, there is no 'waste': the byproducts of one system or organism feed another and this cycling of materials and energy is continuous.

A LCMS is similarly a multidimensional living system, composed of everyone that wants to partake, and even sometimes those that don't. It explores the development of and interconnections between the self, LCMS groups and the larger community ecosystem. A LCMS operates on various levels:

1) the self: a learning dimension for self-development.
2) the self in relation to others: learning one's place in the world.
3) internal group dynamics and interactions between different groups: learning from and with each other, even when different interests are at play.
4) socio-economic interactions: the dynamic between the space-- and its inhabitants-- to the outside world and its contribution to a circular economy.

A LCMS and its respective community enable and encourage the development of each of these levels. To ensure the LCMS is able to respond to each of these levels effectively, it must therefore also be flexible, or liquid. The LCMS takes on the shape of the community, reinventing itself through iterative and agile cycles by continuously evaluating its needs and its function in the community. This may mean adapting everything from the LCMS´s physical layout to how its governed and used.

Diversity & Resilience

In the traditional making chain, a few actors designed the decisions and approaches for the majority. However, a LCMS continuously seeks to break this tradition: a LCMS redefines who is able to make and the space in which it is made, both of which influence one another. In other words, the physical space of the LCMS, and how that space is perceived, can impact how its community is shaped and functions and vice versa. To do this we must take two things in to account:

- Inclusion: all members of society are included and actively recruited to participate in all aspects of the makerspace. Your CMS members look different, come from different backgrounds and have a variety of perspectives.
- Equity: not only are all actors given the opportunity to be part of, and succeed, in the CMS , but actors that have more obstacles are equipped with the tools to actually succeed. This means women, people of color, immigrants, the differently-abled, the elderly--the list goes on-- and particularly people at the intersection of these groups.

Promoting diversity at this level not only facilitates access, but it also makes the LCMS and its makers resilient, able to adapt to new challenges, and capable of learning from and responding to change. Just like in a natural ecosystem, by promoting the inclusion of many different actors -- and the different interests they explore -- the LCMS encourages the development of symbiotic relationships with one another, permitting and

encouraging the cycling of materials, ideas and energies between people and projects and facilitating the emergence of new ideas and collaborations.

Ecosystemic

The survival of all ecosystems in turn relies on the interconnections and flows between them. Makers and the LCMS are no different: they do not exist in a vacuum and are only as capable and resilient as the ecosystem(s) they participate in. This means actively acknowledging and accepting that the activities and work capable of being done by individual makers or in the space itself are limited. Cultivating community, not just within the LCMS but also beyond it enables interdisciplinary thinking; which is essential to acquire, create and test materials and projects but also to make an ideology that can be sustained.

A LCMS therefore also:

- Invites the local communities into the LCMS, to learn about and with them and to co-create and co-design solutions.
- Seeks out cooperation and collaboration with the community around it.
- Facilitates the creation of relationships between community actors.
- Considers dilemmas and solutions that the local community faces.
- Looks for synergies with other surrounding or encompassing ecosystems.

Figure 26 '35 creative talented people: the Fab Lab Barcelona team' 2020

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10. Appendices

Annex 1 tools and guides

CMS resources for working with diverse communities

Further in detail information about the CMS resources for working with diverse communities can be found following this link:
https://docs.google.com/document/d/1ONL_dCOvFNklPd5S2aMLJXnVzlcTKA-M50GU-RxnSt4/edit?usp=sharing

City priorities and 21 Workshops

Further in detail information about the city priorities and 21 workshops can be found at the following link:
https://docs.google.com/spreadsheets/d/1D8j7w-b7GywV5RdcAdUR4n8hr2pEppdZ7xrfxPpaQ-I/edit?usp=sharing

Precious Plastic x Fab Lab & makerspaces

The "Precious Plastic X Fab Lab & makerspaces" and the "How to start Precious Plastic in your maker space" documents are still a work in progress. However we have shared these documents with the Maker Champions to support the set up of their Precious Plastic workshops within the CMSs. Each document can be accessed via the link below.

Precious Plastic X Fab Lab & Makerspaces
https://docs.google.com/document/d/1sQG65lb3aBOu4IBgDi1UBSqi0Ewtf98IQtiHEux2Rm4/edit?usp=sharing

How to start Precious Plastic in your maker space
https://docs.google.com/document/d/1uOADhsHZEc0OZMHkOVovBdWT0RvjplvLnKjN0dSy1s4/edit?usp=sharing

Circular Maker Space Inventory

The following coggle flowchart and CMS Inventory was presented to the Maker Champions to support them on their journey to set up the CMS together with the municipalities. This is a simple guidance and reflection tool which is at the disposal of the Maker Champions. Furthermore they were granted access to the inventory Excel spreadsheets of Fab Lab Barcelona to give them an exemplary overview of which machines, tools, electronics etc. can be bought.

How to start designing your own Maker Space Inventory
The coggle flowchart can be accessed here:
https://coggle.it/diagram/XvzIuWR-uwf02jwQ/t/how-to-start-designing-your-own-maker-space-inventory

Circular Maker Space Inventory
The CMS inventory can be accessed here:
https://drive.google.com/file/d/1S3rjvOODA3c-cVHo_nEtUYMgS658Otde/view?usp=sharing

Annex 2 The Pop-Machina Academy

Further in detail information about each session of the Pop-Machina Academy can be found at the following link: http://pop-machina.eu/academy

Session 01 - June

Inspirational Talk

TOPIC	Pop-Machina
DESCRIPTION	**What?** An introduction of Pop-Machina to the Maker Champions. **Why?** The kick-off session served as an introduction of the project to the Maker Champions to ensure that the vision and mission of Pop-Machina is clear to all the participants of the Academy.
SPEAKER 	Julie Metta is a PhD candidate at the Faculty of Economics, KU Leuven, Belgium, conducting research on Circular Economy. Julie's main research interests are collaborative, behavioural, environmental and resource economics. She is highly involved in multidisciplinary academic projects enhancing sustainable policies. Passionate about sharing and learning about environmental practices, Julie is also socially engaged and dedicated to reducing waste generation and resource consumption, while enhancing civil initiatives.
REFLECTION & TAKE AWAYS	The Maker Champions had a moment to ask questions about Pop-Machina. This was especially important for those who have not been part of Pop-Machina beforehand. Julie Metta was able to explain a holistic overview and the objective of the Project and the presentation was received positively.

Table 01 'Pop-Machina Academy Speaker: Julie Metta', Source: Pop-Machina Academy (https://hackmd.io/@fablabbcn/SyLUuOS38, accessed on November, 2020)

TOPIC	IAAC & Fab Lab Barcelona
DESCRIPTION	**What?** An introduction of Fab Lab Barcelona to the Maker Champions. **Why?** Introducing the Fab Lab Barcelona vision and approach was a crucial starting point at the beginning of the Academy. The way Fab Lab Barcelona works ultimately influences the whole Academy.
SPEAKER 	Xavier Dominguez is part of the Future Learning Unit: a creative laboratory in Fab Lab BCN that favors the development of intelligence, creativity and imagination of children and youth, as well as an educational community based on active learning experiences with design, digital fabrication and coding.
REFLECTION & TAKE AWAYS	Xavier gave a brief introduction to Fab Lab Barcelona,its areas of research, its activities, and the principles which are at the core of its work. The Maker Champions were able to use the presentation of the Lab as inspiration for the future of their CMS.

Table 02 'Pop-Machina Academy Speaker: Xavier Dominguez' Source: Pop-Machina Academy (https://hackmd.io/@fablabbcn/SyLUuOS38#Session-01---The-Academy-Kick-OFF---04062020, accessed on November, 2020)

Interactive Section

During the interactive section each Maker Champion had a moment to present themselves, their background, expertise and expectations from the PMA. One element which the MCs were asked to present was their "superpower". This playful approach serves as a method of presenting a specific characteristic. This feature might be linked directly to making capabilities, but is not limited to that. Basically the MCs were allowed to mention anything they are specifically good at, or known for, as their "superpower". Following this, the MCs were separated into five working groups.

Title	Online Workshop - Building a Local Maker Champion
Purpose	Co-Design by teams a local Maker Champions Profile. Discussing with the rest of the participants what the most important skills for Maker Champions are.
Tools & Materials	Google Slides, Miro
Duration	20 minutes
Output	Maker Champion Profile
Learning Outcomes	Reflection on Maker Champion competences and skills

Table 03 'Pop-Machina Academy Interactive Session: Building a Local Maker Champion'

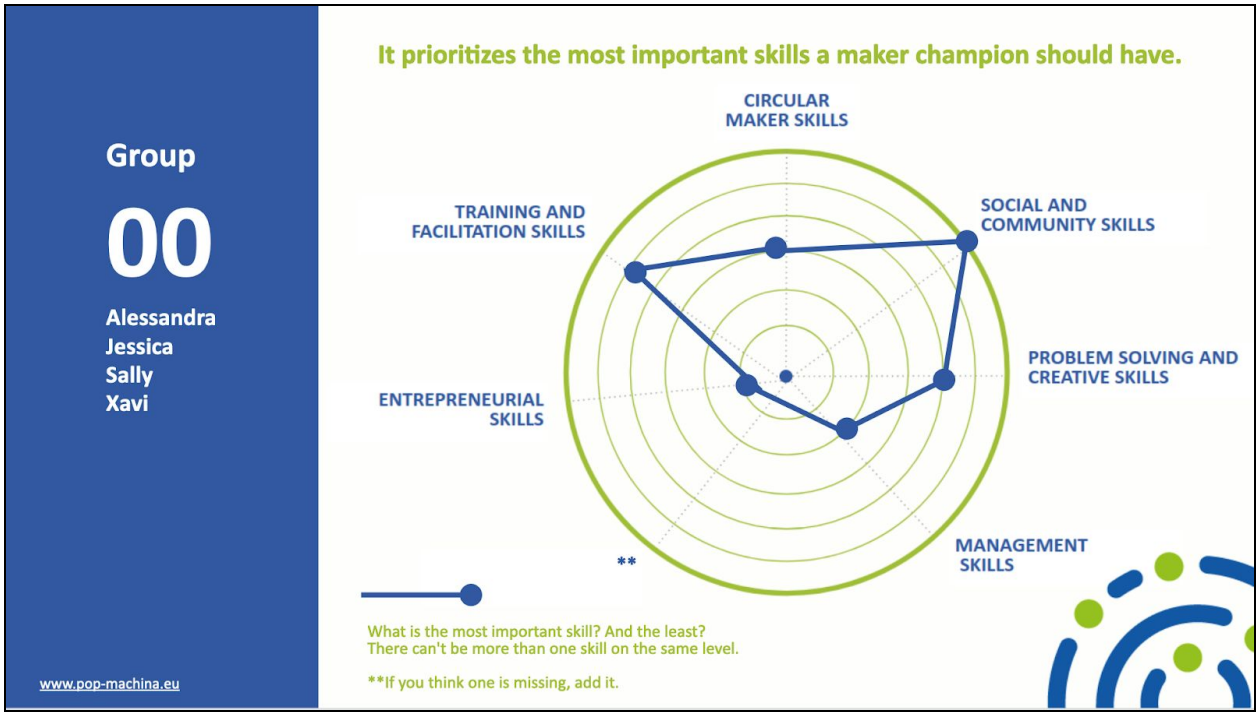


Figure 01 'Pop-Machina Academy Interactive Session: Building a Local Maker Champion Example'

Assignment

Title	Build your own Website
Purpose	The website will serve as a digital space to document the learning journey of each Maker Champion
Tools & Materials	Gitlab (+ tool chosen by Maker Champion)
Output	Maker Champion Website
Learning Outcomes	Explore and use website development tools; Building on or remixing the ideas and projects of others, Teaching and helping one another; Persisting through and learning from failures; Troubleshooting through iterations; Moving from trial-and-error to fine tuning through increasingly focused inquiries

Table 04 'Pop-Machina Academy Assignment: Build your own Website'

Session 02 - June

Inspirational Talk

TOPIC	Building a Circular Maker Space
DESCRIPTION	**What?** During this talk Asger explained the trajectory of Underbroen, a laboratory for local and urban production, its business model, and the different circular maker projects involved. **Why?** The talk served as an inspiration and to share their experience of building a local community (designers, makers and entrepreneurs) and being part of a global circular community.
SPEAKER 	Asger Nørregård Rasmussen holds a MSc in Social Sciences in Social Entrepreneurship and Management from Roskilde University (RUC). He is lab and community manager at maker's lab for local production, prototyping and physical entrepreneurship, Underbroen. Asger is responsible for the engagement and coordination of local communities through cross-sector partnerships and projects. He is the project manager on various EU projects - SISCODE, CIRCuIT and Distributed Design Market Platform (DDMP) - with focus on circular economy and accelerating creative talents. Asger has been working with the maker movement, fab labs and on experimenting with its related design methods in cross-sectoral collaborations since 2014. As Lab and Community Manager he is responsible for organizing and facilitating production-related open innovation activities, design sprints, hackathons and the like – among others, a six-month rat trap hackathon project with the City of Copenhagen.
REFLECTION & TAKE AWAYS	The Maker Champions have asked specific questions about the business model of Underbroen, and the perception of it by the local community. Asgar has also explained details about how local communities are engaged with and communicated with e.g. through connecting and sharing experiences at activities, and keeping in touch via Slack.

Table 05 'Pop-Machina Academy Speaker: Asger Nørregård Rasmussen', Source: Pop-Machina Academy (https://hackmd.io/@fablabbcn/SyLUuOS38#Session-02---Building-a-Circular-Maker-Space---11062020, accessed on November, 2020)

Interactive Section

Title	Introduction to 2D Design
Purpose	Co-Design in teams of a local Maker Champions Profile. Discussing with the rest of the participants what the most important skills for Maker Champions are.
Tools & Materials	Google Slides
Duration	20 minutes
Output	Overview of 2D Design methods and tools
Learning Outcomes	Evaluate and select 2D software Demonstrate and describe processes used in modelling with 2D software; Seeking ideas, assistance, and expertise from others; Building on or remixing the ideas and projects of others, Teaching and helping one another; Collaborating and working in a team; Recognizing and being recognized for accomplishments and contributions

Table 06 'Pop-Machina Academy Interactive Session: Introduction to 2D Design'

Assignment

Title	Design a logo for your Circular Maker Space
Purpose	The exercise does not only introduce the Maker Champions to 2D design but also produces tangible outcomes.
Tools & Materials	Tool chosen by Maker Champion
Output	Logo for the Circular Maker Space
Learning Outcomes	Design Skills; Playfully exploring; Seeking ideas, assistance, and expertise from others; Building on or remixing the ideas and projects of others, Teaching and helping one another; Collaborating and working in a team; Recognizing and being recognized for accomplishments and contributions

Table 07 'Pop-Machina Academy Assignment: Design a logo for your Circular Maker Space'

Session 03 - June

Inspirational Talk

TOPIC	Bio Materials
DESCRIPTION	**What?** Anastasia presented her work as a researcher and educator at Fab Lab Barcelona. Furthermore she showcased the educational programme Fabricademy by presenting multiple examples of her students. **Why?** Anastasia's expertise is one of a kind. Being one of the few people in the Fab Lab Network with such rich knowledge, she is able to bring a very interesting point of view to the Academy.
SPEAKER	Anastasia Pistofidou is a researcher, practitioner and educator on digital fabrication, textiles, wearable technologies and biofabrication. Specialized in hardware development, integration design, rapid prototyping and design to production. Co-founder of fabtextiles.org, a research laboratory on textiles, soft architectures and innovative

	materials at IAAC Fab Lab Barcelona. Co-founder of Fabricademy, Textile and Technology Academy, a radical educational platform on the future of textiles that merges online learning with hands-on prototyping. Combining digital fabrication techniques and crafts, she demonstrates how new technologies can shift massive consumption and fast production to a customized, open-source, personal and local fabrication applied to education, everyday life and new enterprises.
REFLECTION & TAKE AWAYS	Anastasia further explained details about the experience of using biomaterials in direct contact with the human body. Furthermore, she shared links for the Maker Champions for them to be able to apply and explore the possibility of making biomaterials in the CMS. She emphasized that Fab Lab Barcelona is not a space for production, but for knowledge transfer.

Table 08 'Pop-Machina Academy Speaker: Anastasia Pistofidou'', Source: Pop-Machina Academy (https://hackmd.io/@fablabbcn/SyLUuOS38#Session-03---Materials---18062020, accessed on November, 2020)

Interactive Section

Title	Moulding and Casting with Biomaterials
Purpose	Tangible distributed collaborative making experience
Tools & Materials	Stove, pan, scale, cooking utensils, water, agar agar, honey, gelatine, chocolate, milk, objects for moulding and casting, access to freezer
Duration	40 minutes
Output	Casted objects based on materials available from the Maker Champions. Impressions in the form of pictures can be seen following this section.
Learning Outcomes	Demonstrate workflows used in mould design, construction and casting; Demonstrate facilitation design skills with the PM Workshop Canvas; Collaborating and working in teams; Playfully exploring; Connecting projects to personal interests and experiences; Responding aesthetically to materials and phenomena; Persisting through and learning from failures; Troubleshooting through iterations; Moving from trial-and-error to fine tuning through increasingly focused inquiries; Leveraging properties of materials and phenomena to achieve design goals; Adjusting goals based on physical feedback and evidence

Table 09 'Pop-Machina Academy Interactive Session: Moulding and Casting with Biomaterials'

Figure 02 'Pop-Machina Academy Interactive Session: Biomaterials'

Figure 03 'Pop-Machina Academy Interactive Session: Maker Champions moulding and casting outputs '

Assignment

Title	Make a 2-sided mould and cast with different materials and/or make a biomaterial
Purpose	Exploring possible areas of interest, personally for the Maker Champion, or for activities in the CMS. The Maker Champions are applying their gained knowledge, learn through making, and have the possibility to gain tacit knowledge. Through tacit knowledge the Maker Champions

	will have it easier to conduct biomaterial workshop
Tools & Materials	Tool and materials chosen by Maker Champion
Output	A variety of casted objects,
Learning Outcomes	Demonstrate workflows used in mould design, construction and casting; Demonstrate facilitation design skills with the PM Workshop Canvas; Demonstrate 3D CAD design skills; Demonstrate 3D printing process; Collaborating and working in teams; Playfully exploring; Connecting projects to personal interests and experiences; Responding aesthetically to materials and phenomena; Leveraging properties of materials and phenomena to achieve design goals

Table 10 'Pop-Machina Academy Assignment: Make a 2-sided mould and cast with different materials'

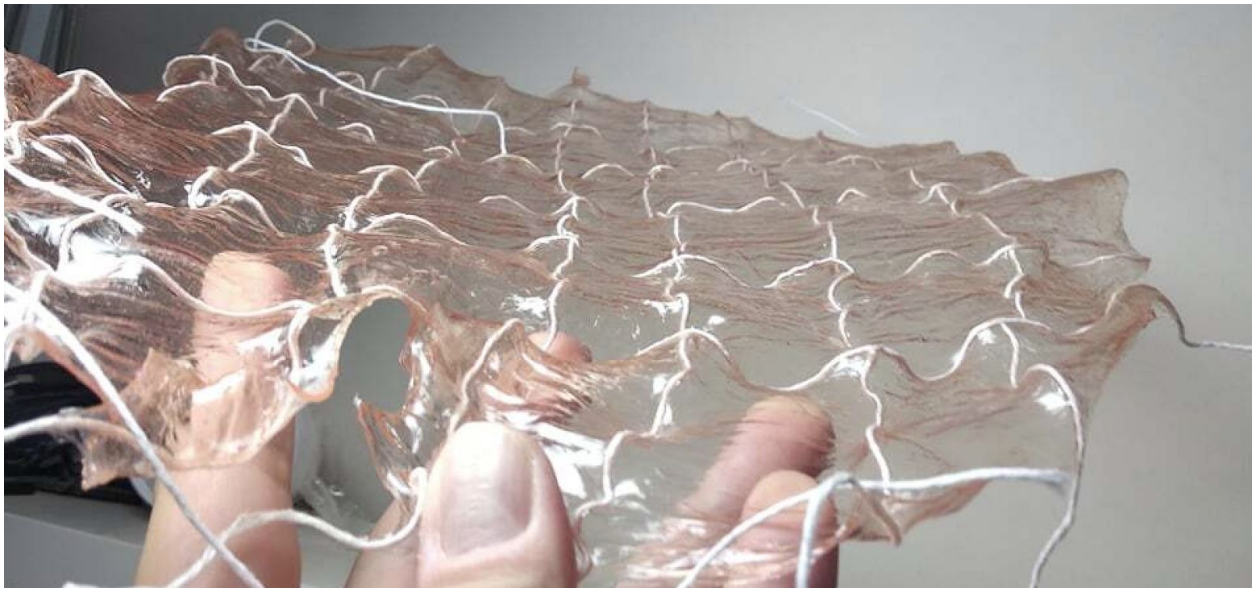


Figure 04 'Pop-Machina Academy Assignment: Maker Champions biomaterials outputs'

Session 04 - June

Inspirational Talk

TOPIC	Building Communities - Remix El Barrio
DESCRIPTION	**What?** In this session, Marion presented and interacted with the Maker Champions about the recent pilot programme we are running in the district of Sant-Marti-Poblenou – a co-creation process to support transition towards circular neighborhoods. The programme focuses on the incubation programme "Remix El Barrio" in which a dozen participants are synergizing and co-developing materials, products and services from local food waste and surplus. **Why?** Collectively the different phases of our community journey have been discussed. Entering into the intimacy of the design and learning processes, some tips and lessons learnt were shared, not only on stakeholder engagement but also on the various co-design workshops, prototyping activities, tools, techniques and projects that were created.
SPEAKER	Marion Real is a systemic design researcher who explores social representation and transformation that occurs during transitions toward circular economies and cosmopolitan localism. She is now working on the SISCODE project at Fab Lab Barcelona to support RRI and co-design approaches in

	different fablabs, living labs and cultural places. She is also an associate researcher at the Centre for Circular Design - UAL and the Institute of Technology ESTIA, leading the Chaire BALI project dedicated to emphasising disruptive material and processes for circular fashion.
REFLECTION & TAKE AWAYS	The Maker Champions asked questions regarding limitations of community building activities, and possibilities to overcome them. In-detail questions about procedures and workflows for the collection of biowaste were asked. Marion was able to share her hands-on insights and experience building a local community of practice in Barcelona.

Table 11 'Pop-Machina Academy Speaker: Marion Real'', Source: Pop-Machina Academy (https://hackmd.io/@fablabbcn/SyLUuOS38#Session-04---Building-Communities-_-Remix-El-Barrio---25062020, accessed on November, 2020)

Interactive Section

Title	What is a Community and how can Pop-Machina Circular Maker Spaces enable circular maker communities?
Purpose	Collaborative brainstorming and insight sharing. Possible starting points on how to build circular maker communities. Sharing these insights gives all of the Maker Champions the possibility to put them into practice in their CMS.
Tools & Materials	Coggle
Duration	40 minutes
Output	A diagram with diverse insights and entry points on how to support the building of communities.
Learning Outcomes	Reflection on the complexity of building a community of practice or circular communities; Building on or remixing the ideas and projects of others; Teaching and helping one another; Collaborating and working in teams; Playfully exploring; Connecting projects to personal interests and experiences; Responding aesthetically to materials and phenomena

Table 12 'Pop-Machina Academy Interactive Session: What is a Community and how can Pop-Machina Circular Maker Spaces enable circular communities?'

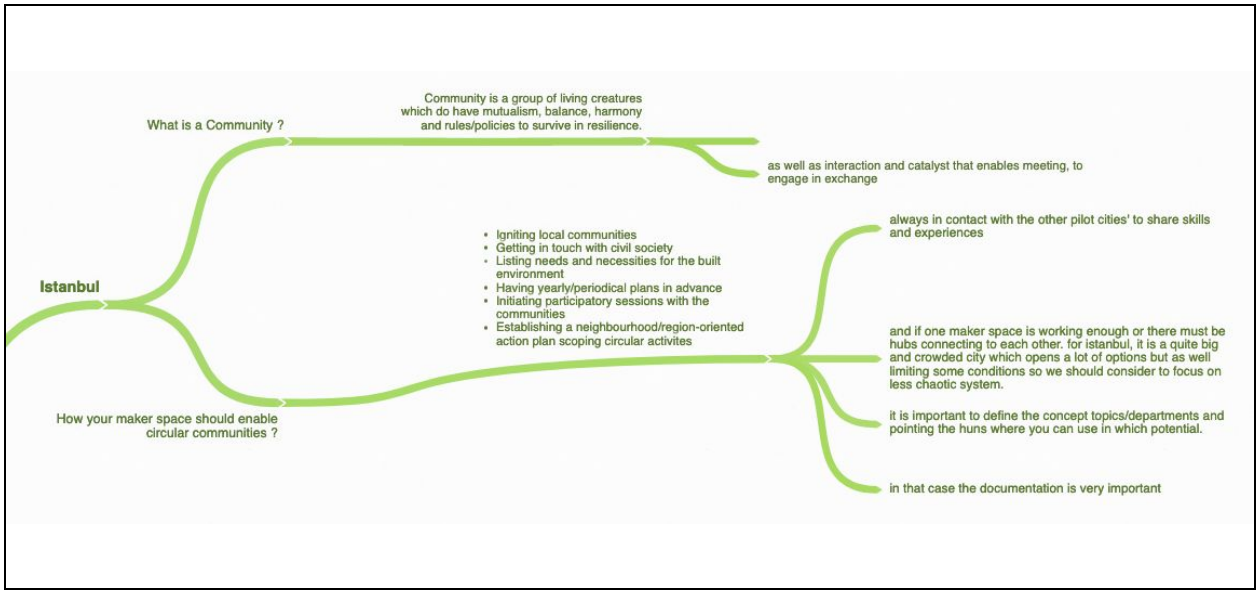


Figure 05 'Pop-Machina Academy Interactive Section: Building circular maker communities'

Assignment

Title	Communities
Purpose	Documenting personal reflections and highlights of Marion's talk. Based on the experience, learnings should be formulated for the Circular Maker Space.
Tools & Materials	Personal online documentation on the Maker Champions website
Output	Documented reflection
Learning Outcomes	Modes of reflection and best practices which may be used in the local Circular Maker Space; Collaborating and working in teams; Open and continuous communication; A common agenda for change; Mutually-reinforcing activities; Construction explanations; Setting one's owns goal, Troubleshooting through iterations; Developing workarounds;

Table 13 'Pop-Machina Academy Assignment: Communities'

After the first month the assignments for the MCs were the same for each week. They were asked to document each session, adding a reflection on how this relates to their future work in the CMS. Learnings and key takeaways were recommended, but it was up to the MCs to decide what and how to document. In the end, the documentation of the processes is a personal one; hence we did not insist how extensive it should be. However, we did mention in each session that we highly recommend documenting everything. Especially, planning in advance, it makes sense to have notes on learnings and actions for the CMS. For this reason, there are no assignment tables in the following description of the content of each session.

Session 05 - July

Inspirational Talk

TOPIC	Precious Plastic
DESCRIPTION	**What?** An inspirational talk about Precious Plastic.

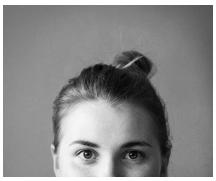
	Why? Many of the makerspaces are interested in setting up a Precious Plastic workspace. Setting up such space improves the circular material flows within the workshops of the CMS. The approach of Precious Plastic follows the same principles as the Fab Lab Network, which is locally productive and globally connected.
SPEAKER 	Katharina Elleke (26) studied Industrial Design in Munich. Focusing her activities on environmental issues, and particularly on plastic waste, she got involved in the Flipflopi project (Kenya) as well as Precious Plastic (Netherlands), both aiming to tackle plastic pollution. During her three years as a Precious Plastic team member, her main responsibilities have been in the fields of communication, community building, and online platform/website management, but she has generally been involved in basically every area connected to the project – from strategy, planning and coordination, video filming and editing, machine building and testing, process documentation, as well as educational trainings and guidance for projects (e.g. in Bangladesh and Kenya). And then there is also this Flipflopi boat made from Kenyan beach waste, upon which she takes part in expeditions and educates about solutions along the way - but that's another story :)
REFLECTION & TAKE AWAYS	Insights into connected local networks, sharing information globally and with other ecosystems and communities. Katherina was able to answer in detail questions about the impact of the Precious Plastic community. Furthermore, she shared in-practice methods and insights from the community itself. Also, the Maker Champions were made aware, once again, that there are existing maker networks in which one may find possible ways of interaction and knowledge transfer.

Table 14 'Pop-Machina Academy Speaker: Katharina Elleke', Source: Pop-Machina Academy (https://hackmd.io/@fablabbcn/SyLUuOS38#Session-05---Precious-Plastic-Party--_-02072020, accessed on November, 2020)

Figure 06 'Pop-Machina Academy Inspirational Talk: Precious Plastic'

Interactive Section

Title	Show and Tell of Documentation
Purpose	Reviewing the process of the Maker Champions, giving feedback and opening up the conversation to any possible questions.
Tools & Materials	Personal documentation on the Maker Champions website
Duration	40 minutes
Output	Feedback for each Maker Champion
Learning Outcomes	Collaborating and working in teams; Persisting through and learning from failures; Constructing explanations; Open and continuous communication; Mutually-reinforcing activities; Troubleshooting through iterations

Table 15 'Pop-Machina Academy Interactive Session: Show and Tell of Documentation'

Session 06 - July

Inspirational Talk

TOPIC	Being a Lab Manager
DESCRIPTION	**What?** Introduction to the responsibilities and principles of being a Fab Lab Manager **Why?** Mikel and Josep shared their hands-on experiences of what it means to be a manager of a makerspace such as Fab Lab Barcelona. This provided the Maker Champions with insights, inspiration and ideas for their deployment in a Circular Maker Space.
SPEAKER  	Mikel Llobera is a maker and designer from Barcelona. He studies arts, design and programming for video games. His aim was to leave the virtual worlds behind and therefore joined Fab Lab Barcelona to learn about 3D printing. After this immersive experience as an intern at the Lab, he has become a Fab Lab Manager. Josep Marti is an Industrial Engineer from Barcelona. He is passionate about new technologies and making things. He decided to leave his office career as a Bl consultant to graduate from Fab Academy and dedicate his working life to the Fab Lab as an assistant manager. He is part of the Future Learning Unit.
REFLECTION & TAKE AWAYS	The session offered hands-on knowledge of what it means to work in a Fab Lab or makerspace. Both speakers offered a variety of insights on general information and practical and day-to-day operations.

Table 16 'Pop-Machina Academy Speaker: Mikel Llobera & Josep Marti', Source: Pop-Machina Academy (https://hackmd.io/@fablabbcn/SyLUuOS38#Session-06---Being-a-Lab-Manager-_09072020, accessed on November, 2020)

Interactive Section

Title	Building Your Ideal Circular Maker Space
Purpose	Speculative workshop to imagine CMS and linking the UN Sustainable Development Goals (SGD's) to the objectives of the CMS. The workshop helps to imagine the CMS profile by defining it in three words – dimensions and budget available. Additionally, aspects such as focus of work, community impact, space distribution, and organisation are reflected upon.
Tools & Materials	Google Slides
Duration	40 minutes
Output	Speculative design of a CMS based on real values
Learning Outcomes	Contextualisation of what it means to build a CMS; Controlling for variables as project complexities; Collaborating and working in teams; Adjusting goals based on physical feedback and evidence; A backbone coordination organisation

Table 17 'Pop-Machina Academy Interactive Session: Building your ideal Circular Maker Space'

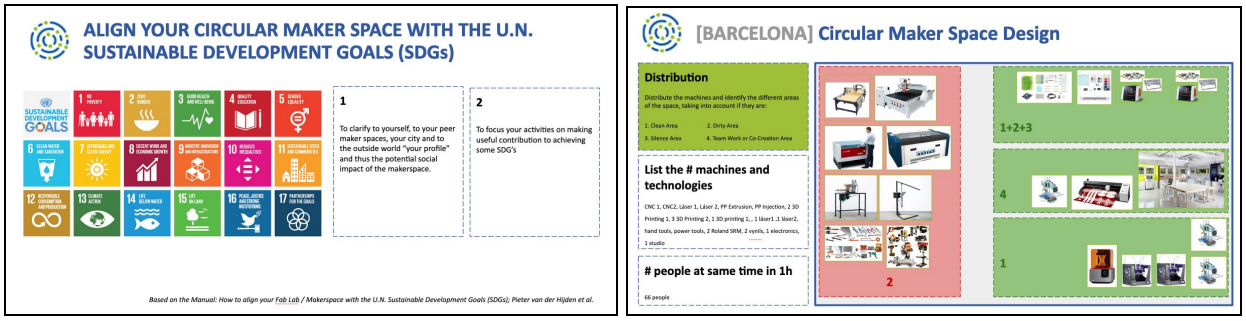


Figure 07 'Pop-Machina Academy Interactive section: Building your ideal Circular Maker Space '

Session 07 - July

Inspirational Talk

TOPIC	How to 3D Print Almost Anything
DESCRIPTION	**What?** Designing with additive manufacturing processes, and 3D printing almost anything. **Why?** The talk from Eduardo does not only serve as an inspiration for the Maker Champions, but provides technical input. The session from Eduardo widened the perception of what can be done with 3D printing methods. 3D printing offers many possibilities for exploration and rapid prototyping.
SPEAKER 	Eduardo Chamorro is an architect and researcher who works to discover how technology can transform architecture and its processes to improve people's lives. He holds a Master Degree of Architecture from CEU San Pablo University (Spain), a Fab Academy diploma in Digital Fabrication offered by the Fab Lab Network, and a Master Degree in Advanced Architecture from IAAC (Spain), with a specialization in digital fabrication, materiality and new design methodologies. He holds a Spanish architectural licence. In addition, he has worked as Fab Lab Seoul director and researcher in several architecture studios, as a computational design and fabrication professor at CEU University, and as an advisor/fabrication expert for different architecture collectives. He is a frequent collaborator at Fab Lab Madrid. He is always seeking to achieve an innovative architecture that attempts to provide solutions and adapt to social needs. He is currently a Phd candidate at Swinburne University (Melbourne, Australia). As a digital fabrication expert, he is faculty in the Master in Advanced Ecological Buildings, OTF Printing in Architecture, Master in Design for Emergent Futures at IAAC Fab Lab Barcelona. For him, working in a multi-scalar environment must be the priority for an architect nowadays.
REFLECTION & TAKE AWAYS	Eduardo was able to showcase the many possibilities of 3D printing. He shared his exploratory yet structured practices while working with different 3D printers and extrusion methods. The Maker Champions were able to not only ask technical questions, but were engaged to apply more exploratory ways of working with additive manufacturing as well.

Table 18 'Pop-Machina Academy Speaker: Eduardo Chamorro', Source: Pop-Machina Academy (https://hackmd.io/@fablabbcn/SyLUuOS38#Session-07---How-to-3D-Print-almost-anything-_15072020, accessed on November, 2020)

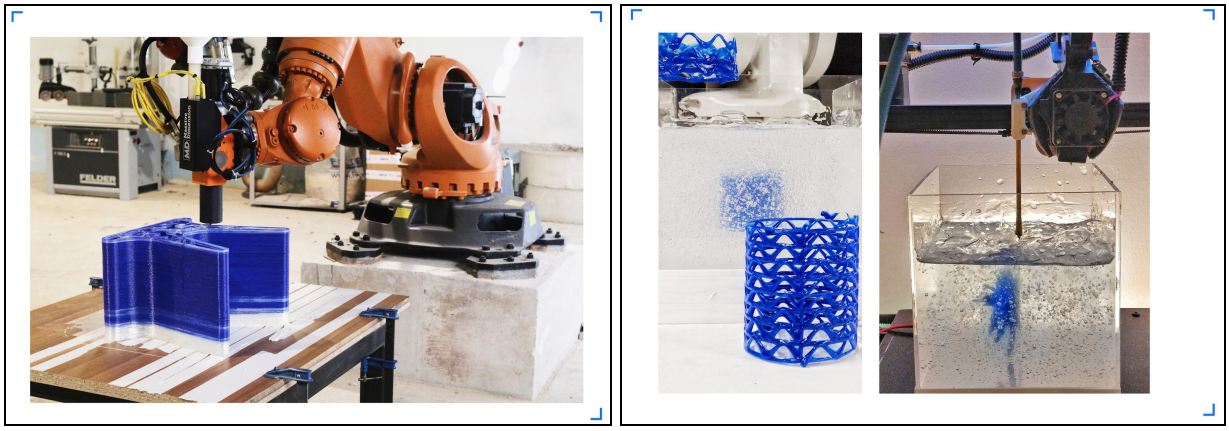


Figure 08 'Pop-Machina Academy Inspirational Talk: How to 3D print almost anything'

Interactive Section

Title	Community Engagement in the Time of COVID-19
Purpose	To support the Maker Champions to adapt physical activities into online experiences. To showcase distributed means of making, based on projects made during the COVID-19 confinement at Fab Lab Barcelona.
Tools & Materials	Google Slides
Duration	40 minutes
Output	Inspiration for activities which can be conducted in the CMS
Learning Outcomes	Reflection on how to contextualize interactive and tangible learning experience online; Know design principles for prototyping and manufacturing real artefacts; Responding aesthetically to materials and phenomena; Connecting projects to personal interests and experiences; Playful exploring

Table 19 'Pop-Machina Academy Interactive Session: Community Engagement in the Time of COVID-19'

Session 08 - July

Inspirational Talk

TOPIC	Design Pilot City Activities
DESCRIPTION	**What?** The design of Pilot City activities led by the KU team from WP5. **Why?** The collaborative session linked the workflows and exchange of information between the Maker Champions and the Municipalities for a holistic idea of the setup of the Circular Maker Space and Pilot.
SPEAKER 	Yekta Bakırlıoğlu is a design researcher with an interest in open design, design for sustainability, sustainable production and consumption, and design education for sustainability; he is a postdoctoral researcher in the Department of Media and Visual Arts, Koç University. María Laura Ramírez is a Ph.D. student at Koç University in the Design, Technology, and Society

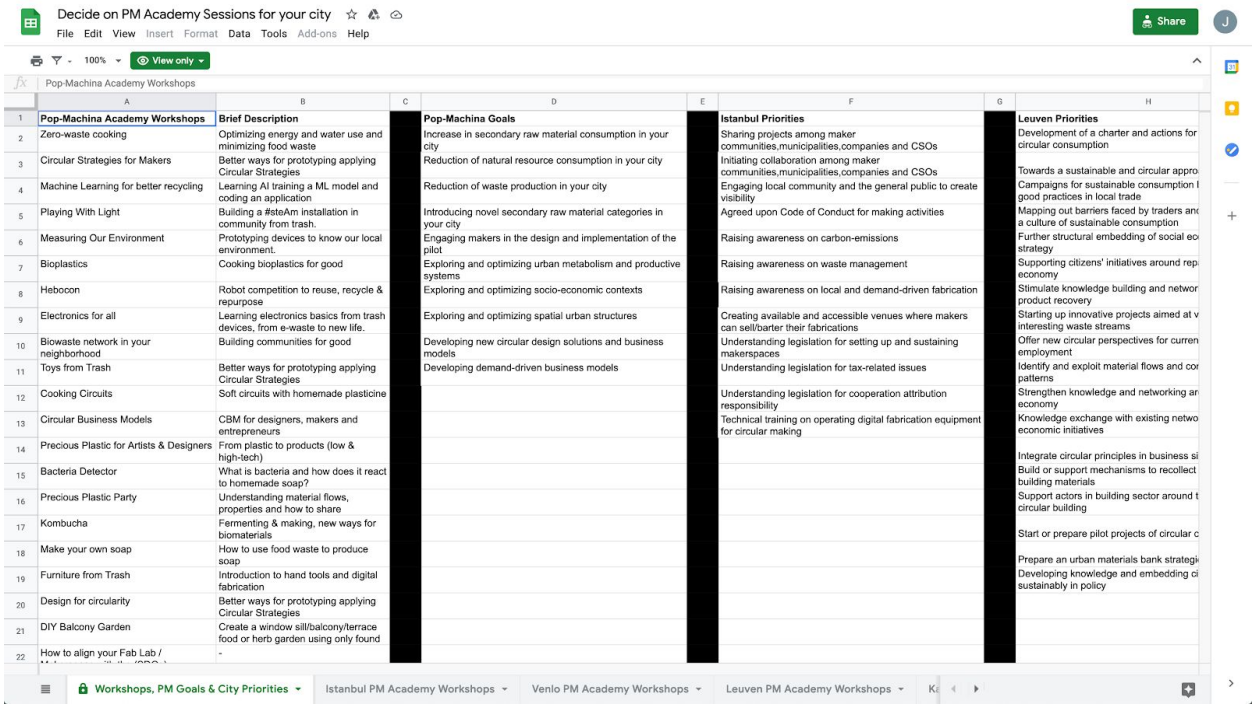
 	programme and part of the IxD Research Group. Her research is focused on promoting and making meaningful social interactions between people from culturally different backgrounds in public places. She received her bachelor's degree in business engineering and her master's degree in Innovation and Design at Adolfo Ibáñez University, Chile. Her research interests are social innovation, creativity skills, co-creation, Participatory Design, and design research methods. Damla Çay is an interaction design researcher from KUAR, Koç University. She does research on collaborative design methods for data visualizations and designing interactive visualization tools.
REFLECTION & TAKE AWAYS	For successful set up of a CMS and pilot, the municipalities and Maker Champions have to work as a team. To support this the best way possible, the deliverables and tasks generated in Pop-Machina between different partners should be as synchronized as possible.

Table 20 'Pop-Machina Academy Speaker: Yekta Bakırlıoğlu, María Laura Ramírez, Damla Çay', Source: Pop-Machina Academy (https://hackmd.io/@fablabbcn/SyLUuOS38#Session-08---Design-Pilot-City-Activities, accessed on November, 2020)

Interactive Section

Title	Local Future Stories, Matching Priorities with 21 Workshop Repository
Purpose	The activity has been adapted to an online individual activity in which participants are asked to create a story about the future by answering 4 questions in an online form. To create the "future stories" mindset, the participants start by watching an introductory video that will last between 2 to 3 minutes. This activity is aimed at engaging communities around the makerspace on the project and, at the same time, future participants are collected. Furthermore, we have used the opportunity to revise the city priorities and match them with at least 10 workshops from the 21 Workshop Repositories. The Maker Champions also had the opportunity to add any workshops they identified as useful.
Tools & Materials	Online form and video script provided by WP5, Excel for matching, and Google slide presentation for the City Priorities and Workshops
Duration	60 minutes
Output	Local future stories collaboratively made by cities, Maker Champions with curation of WP5, Mind Setting video. Ten workshops matching the city priorities which will be conducted during the pilot deployment.
Learning Outcomes	Storytelling to share the local narrative and goals of the pilots; Mutually-reinforcing activities; Open and continuous communication; A backbone coordinating organizations; A common agenda for change, Shared measurement for data and results;

Table 21 'Pop-Machina Academy Interactive Session: Local Future Stories'



Pop-Machina Academy Workshops	Brief Description	Pop-Machina Goals	Istanbul Priorities	Leuven Priorities
Zero-waste cooking	Optimizing energy and water use and minimizing food waste	Increase in secondary raw material consumption in your city	Sharing projects among maker communities,municipalities,companies and CSOs	Development of a charter and actions for circular consumption
Circular Strategies for Makers	Better ways for prototyping applying Circular Strategies	Reduction of natural resource consumption in your city	Initiating collaboration among maker communities,municipalities,companies and CSOs	Towards a sustainable and circular appro
Machine Learning for better recycling	Learning AI training a ML model and coding an application	Reduction of waste production in your city	Engaging local community and the general public to create visibility	Campaigns for sustainable consumption l good practices in local trade
Playing With Light	Building a #steAm installation in community from trash.	Introducing novel secondary raw material categories in your city	Agreed upon Code of Conduct for making activities	Mapping out barriers faced by traders an a culture of sustainable consumption
Measuring Our Environment	Prototyping devices to know our local environment.	Engaging makers in the design and implementation of the pilot	Raising awareness on carbon-emissions	Further structural embedding of social ec strategy
Bioplastics	Cooking bioplastics for good	Exploring and optimizing urban metabolism and productive systems	Raising awareness on waste management	Supporting citizens' initiatives around rep economy
Hebocon	Robot competition to reuse, recycle & repurpose	Exploring and optimizing socio-economic contexts	Raising awareness on local and demand-driven fabrication	Stimulate knowledge building and networ product recovery
Electronics for all	Learning electronics basics from trash devices, from e-waste to new life.	Exploring and optimizing spatial urban structures	Creating available and accessible venues where makers can sell/barter their fabrications	Starting up innovative projects aimed at v interesting waste streams
Biowaste network in your neighborhood	Building communities for good	Developing new circular design solutions and business models	Understanding legislation for setting up and sustaining makerspaces	Offer new circular perspectives for curren employment
Toys from Trash	Better ways for prototyping applying Circular Strategies	Developing demand-driven business models	Understanding legislation for tax-related issues	Identify and exploit material flows and cor patterns
Cooking Circuits	Soft circuits with homemade plasticine		Understanding legislation for cooperation attribution responsibility	Strengthen knowledge and networking ar economy
Circular Business Models	CBM for designers, makers and entrepreneurs		Technical training on operating digital fabrication equipment for circular making	Knowledge exchange with existing netwo economic initiatives
Precious Plastic for Artists & Designers	From plastic to products (low & high-tech)			Integrate circular principles in business si
Bacteria Detector	What is bacteria and how does it react to homemade soap?			Build or support mechanisms to recollect building materials
Precious Plastic Party	Understanding material flows, properties and how to share			Support actors in building sector around t circular building
Kombucha	Fermenting & making, new ways for biomaterials			Start or prepare pilot projects of circular c
Make your own soap	How to use food waste to produce soap			Prepare an urban materials bank strategi
Furniture from Trash	Introduction to hand tools and digital fabrication			Developing knowledge and embedding ci sustainably in policy
Design for circularity	Better ways for prototyping applying Circular Strategies			
DIY Balcony Garden	Create a window sill/balcony/terrace food or herb garden using only found			
How to align your Fab Lab /	-			

Figure 09 'Pop-Machina Academy Interactive Session: City Priorities and 21 Workshops'

Session 09 - July

Inspirational Talk

TOPIC	Learning Ecosystems
DESCRIPTION	**What?** Santi introduced the Future Learning Framework to design learning ecosystems based on a multiscale approach within innovation labs. We will discuss toolkits, methodologies, communities and facilities. Santi's talk was not only dedicated to elaboration on the educational programmes from Fab Lab Barcelona, but also to explain what and how learning ecosystems are being implemented. **Why?** The Pop-Machina Academy is based on the experience of the learning environments taking place in the Fab Lab Network. Santi explained in more detail his experience, and the research which has led to this way of work.
SPEAKER 	Master degree in Architecture from the University of La Salle (Universitat Ramon Llull), Spain. In 2012 he graduated from the Fab Academy, an intensive 6-month digital manufacturing and rapid prototyping programme led by Neil Gershenfeld at MIT's Center for Bits and Atoms (CBA). He is currently doing the PHD in digital manufacturing processes at the EGA UPC (Universitat Politècnica de Catalunya). As a professional architect, Santi has worked in several architecture companies carrying out projects at an international level for more than 10 years. Since 2013 he has been part of the Fab Lab BCN team. He is the leader of the Future Learning Unit (FLU), the unit focused on the design, implementation and coordination of active learning experiences with digital manufacturing tools for the community. FLU designs and promotes education, innovation and entrepreneurship projects such as AmbMakers, POPUPLAB, "Digital Fabrication Everywhere", FABKIDS, and CROCOPOI. FLU participates in European research projects such as DO IT or DSISCALE and, since 2014, he has been Fab Guru of the global academic programme FabAcademy. Since 2017 he has been faculty at the Master in Design for Emergent Futures (MDEF), organized by IAAC.
REFLECTION	The Maker Champions had the possibility to ask more detailed questions about how the learning

& TAKE AWAYS	framework contributes to building communities, especially times of COVID-19. It creates a hyperconnected learning ecosystem that provides feedback whilst navigating between home, Circular Maker Spaces and cities.

Table 22 'Pop-Machina Academy Speaker: Santi Fuentemilla', Source: Pop-Machina Academy (https://hackmd.io/@fablabbcn/SyLUuOS38#Session-09---Learning-Ecosystems, accessed on November, 2020)

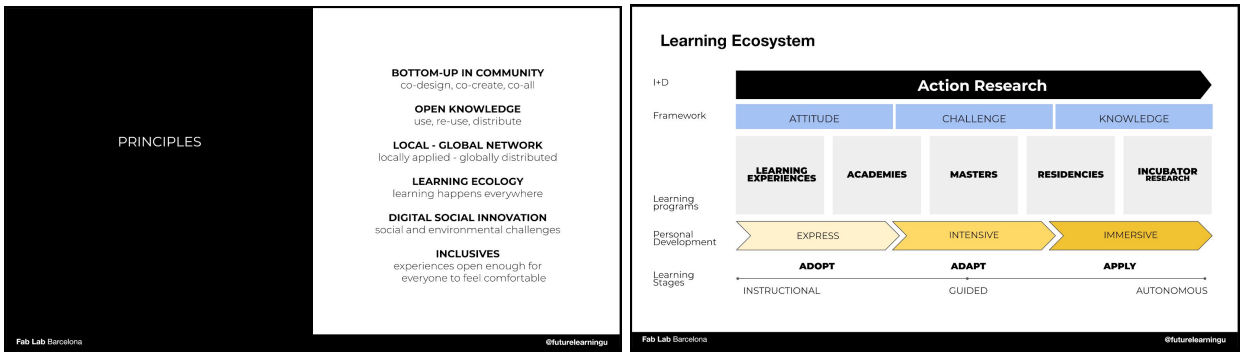


Figure 10 'Pop-Machina Academy Inspirational Talk: Learning Ecosystems'

Interactive Section

Title	Circular Economy Framework – In COVID-19
Purpose	A reflection exercise together with Santi Fuentemilla and the Maker Champions to together imagine how Circular Economy Framework, in a Circular Maker Space, can develop during times of covid.
Tools & Materials	Padlet
Duration	40 minutes
Output	A Padlet with inspiration for future activities for the Maker Champions
Learning Outcomes	Persisting through and learning from failures; Adjusting goals on physical feedback and evidence; Taking intellectual and creatives risks; Working without a blueprint; Troubleshooting through iterations; Moving from trial-and-error to fine tuning; Developing work-arounds; Seeking ideas, assistance, and expertise from others; A shared measurement for data and results; Mutually reinforcing activities; Open and continuous communication; Building on or remixing the ideas and projects of others; Collaborating and working in teams

Table 23 'Pop-Machina Academy Interactive Session: Circular Economy Framework – In COVID-19'

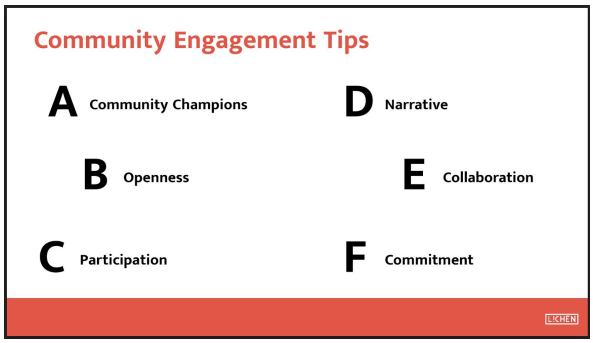
Session 10 - September

Inspirational Talk

TOPIC	Best Practices and Tools for Community Orchestration
DESCRIPTION	**What?** Matias Verderau (Lichen Social Innovation Director, lichenis.com) will share his experience and the role of makerspaces in social development, participatory processes, and projects which address environmental issues (with a focus on adaptiveness during COVID-19). **Why?** For example, he will elaborate on the methodology developed in the Europeen Project making-sense.eu and the impact it had on the different cities and their respective communities.

SPEAKER 	Matias Verderau has a Degree in Business Administration and Management, Master of Science in Marketing and Master in Branding. Collaborator at Fab Lab Barcelona IAAC as Digital Social Innovation Project Manager, and Production Manager. Experience in social development, participatory processes and environmental issues, in Latin America and Europe, through Institutions, public and private projects – European projects like Making Sense Horizon 2020, MAKE-IT Horizon 2020, DSISCALE H2020, ROMI H2020, and Distributed Design Market Platform Creative Europe. Also Fablabs.io, the official and open source platform for the global Fab Lab Network, Red Bull Basement 2019 edition and Aigües de Barcelona Maker League, among others.
REFLECTION & TAKE AWAYS	Matias shared practices and approaches to community engagement, especially in relation to digitalisation and education. He has explained the need for a human approach and interactions for successful deployment. He emphasizes how important it is to have conversations with your target group to truly understand the needs of the community.

Table 24 'Pop-Machina Academy Speaker: Matias Verderau' , Source: Pop-Machina Academy (https://hackmd.io/@fablabbcn/SyLUuOS38#Session-10---Best-Practices-and-Tools-for-Community-Orchestration, accessed on November, 2020)



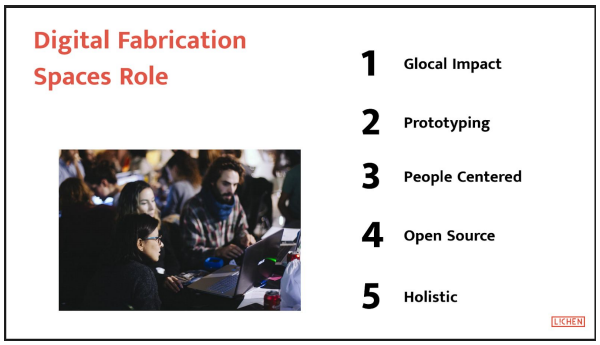


Figure 11 'Pop-Machina Academy Inspirational Talk: Best Practices and Tools for Community Orchestration'

Interactive Section

Title	Pop-Machina Champions - Goals and Concerns
Purpose	To map the expectations and concerns from out Maker Champions Community to find partners in the consortium who can support them.
Tools & Materials	Padlet
Duration	40 minutes
Output	An online list of goals and concerns from the Maker Champions, which can be revised and updated at any time. This served Fab Lab Barcelona in gathering additional inputs for the immersive training month, October.
Learning Outcomes	Adjusting goals on physical feedback and evidence; Taking intellectual and creatives risks; Troubleshooting through iterations; Moving from trial-and-error to fine tuning; Developing work-arounds; Seeking ideas, assistance, and expertise from others; A shared measurement for data and results; Mutually-reinforcing activities; Open and continuous communication; Collaborating and working in teams

Table 25 'Pop-Machina Academy Interactive Session: Pop-Machina Champions - Goals and Concerns'

Session 11 - September

The session 11 did not have an inspirational talk from an external guest speaker. This session was a two-hour workshop to collect data for digital social innovation, putting in practice contexts from the talk the previous week from Matias. The Maker Champions were asked prior to this workshop to acquire access (if possible) to an Android phone, and to download previously shared .zip files. This workshop required an arrangement of tools which were new to the MCs, so we decided to use the full two hours. The workshop was designed to be fluid yet it had a clear goal which was: designing a simple app for an Android phone, using the existing microphone in the phone to measure noise directly at the location of the participant. Designing fluid workshops means that the facilitator adapts to the participants' pace during the workshop. In practice this requires the facilitator to prepare for different scenarios, one being that many participants might have a different level of knowledge, or might not have access to the needed tools. Others are, for example, that the pace of the workshop might be faster than expected, making additional material necessary. It can be challenging to address all the needs from all the participants, especially when they have different skill levels. In a physical workshop this can be more easily addressed through having multiple facilitators who group participants by expertise. Online this is a bit more challenging, so trying to find a common ground to work with is crucial. Also, there is normally less engagement with such online workshops. As a participant it is easier to lose track and simply 'tune out'. This is not as often the case during a workshop in which all participants are physically present. The change of our approach, to more interactive sessions, including technical content, was due to the transition to the immersive training month of October. Hence, the following session 12 doesn't have an inspirational talk either – it is fully dedicated to a technical workshop.

Interactive Section

Title	Collecting Data for Digital Social Innovation
Purpose	Hands-on experience with coding, data collection and visualisation. To understand the process of information flows, basics of coding and impact of environmental data.
Tools & Materials	MIT Appinventor, NodeRED, Android Phone
Duration	2 hours
Output	A basic app and a dashboard which displays the noise levels
Learning Outcomes	Adjusting goals on physical feedback and evidence; Troubleshooting through iterations; Moving from trial-and-error to fine tuning; Developing work-arounds; Seeking ideas, assistance, and expertise from others; Collaborating and working in teams; Know design principles for prototyping and manufacturing real artefacts; Connecting projects to personal interests and experiences; Playful exploring

Table 26 'Pop-Machina Academy Interactive Session: Collecting Data for Digital Social Innovation'

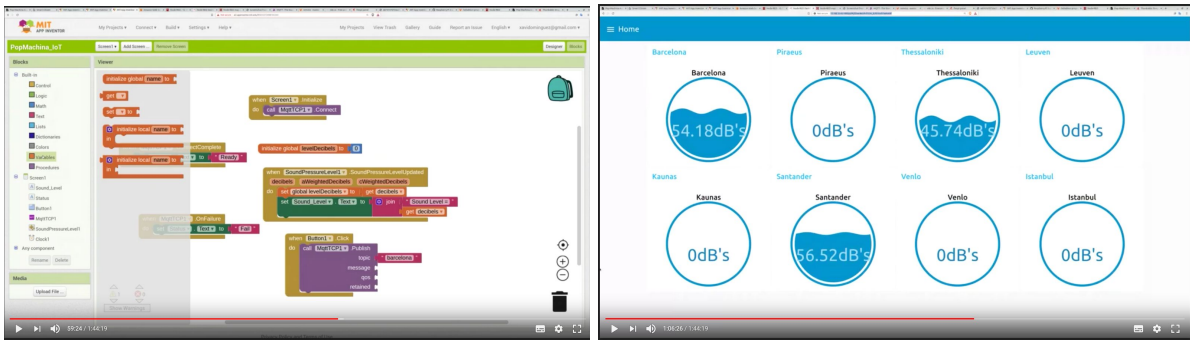


Figure 12 'Pop-Machina Academy Inspirational Talk: Collecting Data for Digital Social Innovation'

Session 12 - September

Interactive Section

Title	Learning Electronics Basics
Purpose	Basic knowledge of electronics and introduction to reuse and repair of electronic waste for new purposes.
Tools & Materials	E-Waste, tools for dismantling, soldering iron and solder, multimeter
Duration	2 hours
Output	Depending on each Maker Champion, basic understanding of electronics, hands-on experience with disassembly and assembly of hardware
Learning Outcomes	Adjusting goals on physical feedback and evidence; Troubleshooting through iterations; Moving from trial-and-error to fine tuning; Developing work-arounds; Seeking ideas, assistance, and expertise from others; Collaborating and working in teams; Know design principles for prototyping and manufacturing real artefacts; Connecting projects to personal interests and experiences; Playful exploring

Table 27 'Pop-Machina Academy Interactive Session: Learning Electronics Basics'

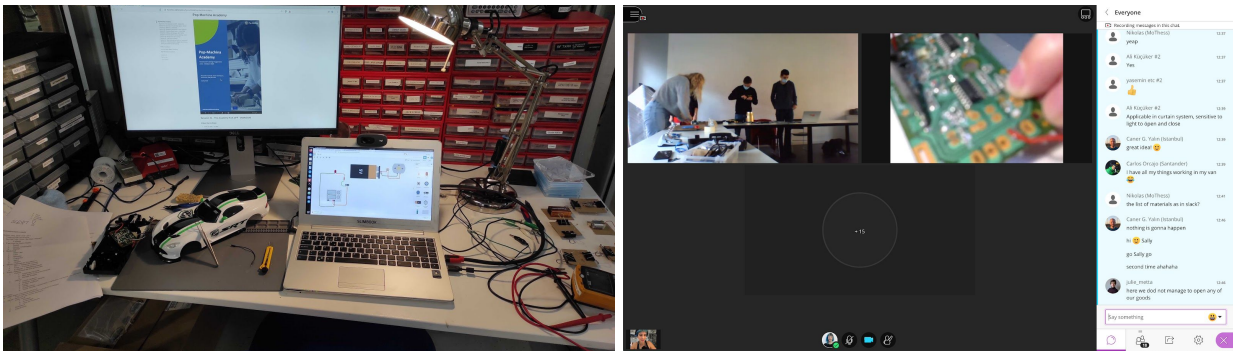


Figure 13 'Pop-Machina Academy Inspirational Talk: Learning Electronics Basics'

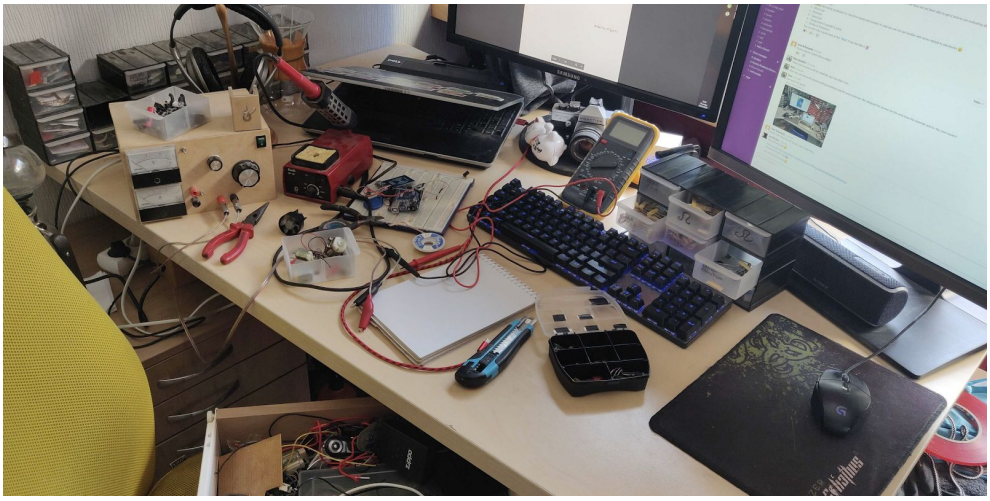


Figure 14 'Pop-Machina Academy Interactive Session: Maker Champions Learning Electronics Basics setup at home'

Session 13 - October

Inspirational Talk

TOPIC	Circular Maker Spaces and Urban Regeneration Strategies
DESCRIPTION	**What?** The talk from Chiara and Andrea demonstrated the material flow analyses from each respective Pilot City, produced for the D3.1. **Why?** Giving context on the city scale via understanding material flows for local challenges in a circular economy. By understanding material flows in the cities, Maker Champions may be inspired to know how and where to step into the local ecosystem, and connect making activities directly. This session refers to the first step of the Co-Creation Journey: "Analyzing the context".
SPEAKER  	Chiara Farinea is an Architect and Urban Planner, PhD. Master in Architecture at POLIMI Milan (2004), Post-graduate Master in Advanced Architecture at IAAC Barcelona (2007). She discussed a doctoral thesis at IUAV University of Venice on Urban and Environmental planning (2014). Currently she is Head of European Projects at the Advanced Architecture Group Department at IAAC, coordinator of research projects related to education, co-design action and nature-based solution implementation. Her research interests focus on digital fabrication applied to natural-based solutions in cities, and eco-design of living systems. Andrea Conserva is an Italian architect, building engineer and researcher. His research focuses on creating a sustainable future for our cities through advanced technologies and innovation. He is currently EU Project Manager at the Advanced Architecture Group Department at IAAC in Barcelona where he is coordinator and scientific personnel of several EU R&D projects targeted at urbanism and sustainability. Andrea obtained a Master of Science in Architectural Engineering from the Politecnico of Milan (2013) and started his professional career (2014) as a technical Researcher and Project Manager in the Sustainable Building group, from the Energy Efficiency Area of the Research Centre for Energy Resources and Consumption (CIRCE) in Zaragoza, Spain. He managed several EU funded (e.g. FP7, H2020) and private projects and developed his expertise in Energy Efficiency and Sustainable Building Modelling, Simulation and Assessment.
REFLECTION & TAKE AWAYS	The session gave an overview to the Maker Champions on what kind of work is being done in other "research areas" of Pop-Machina. In the future, the Maker Champions can engage with their local stakeholders and maker ecosystem actors and collaboratively define challenges which take place directly in "real world" settings.

Table 28 'Pop-Machina Academy Speaker: Chiara Farinea and Andrea Conserva ', Source: Pop-Machina Academy (https://hackmd.io/@fablabbcn/SyLUuOS38#Session-11---Collecting-Data-for-Digital-Social-Innovation, accessed on November, 2020)

Interactive Section

Title	Co-creation Journeys
Purpose	Introduction to a step-by-step guide to support the co-creation of a Circular Maker Space, with inputs from SISCODE and Making Sense. In city teams the Maker Champions filled in the Communications Canvas for Stakeholder Engagement.
Tools & Materials	Google Slides
Duration	40 minutes
Output	Communications Canvas for Stakeholder Engagement

Learning Outcomes	Constructing explanations; Using analogies and metaphors to explain; A common agenda for change; Mutually-reinforcing activities; Open and continuous communication; Collaborating and working in teams

Table 29 'Pop-Machina Academy Interactive Session: Co-creation Journeys '

Session 14 - October

Interactive Section

Title	Collaborative Sessions: Municipalities and Champions
Purpose	**What?** A joint session with WP5 which is in charge of the pilot deployment. The aim of the session was to collaboratively decide which workshops could be implemented in the CMS. The city partners and Maker Champions worked together in 'city teams' to match the city priorities with workshops from the 21 Workshops repository provided by IAAC & Fab Lab Barcelona. The 21 Workshops serve as an inspiration. However, the Maker Champions are free to add other Workshops or activities which they find more suitable. **Why?** To further foster the relation between the city partners and the Maker Champions, another collaborative session was held to align the workflows for the future of the Circular Maker Space and pilots. This session contributes to the second and third step of the Co-creation Journey: "Framing the challenge" and "Prototyping activities"
Tools & Materials	Google Slides, Google sheets
Duration	1.5 hours
Output	Extensive repository of workshops matching the city priorities for the pilot deployment, and to take place in the CMS.
Learning Outcomes	Setting one's own goal; Building on or remixing the ideas and project of others; A common agenda for change; Mutually-reinforcing activities; Open and continuous communication; Collaborating and working in teams; Recognizing and being recognized for accomplishments and contributions

Table 30 'Pop-Machina Academy Interactive Session: Collaborative Sessions: Municipalities and Champions'

	PM Academy Workshop	Online or Offline?	Volunteers	Target Group
1	Zero-waste cooking	Both	Yasemin	HORECA, kitchen people
2	Bioplastics	Both	Yasemin	design students,
3	Biowaste network in your neighborhood	Both	Onur Yasemin	neighbors
4	Electronics for all	Both	Onur	students from 10-14.

Figure 15 'Pop-Machina Academy October - Collaborative Sessions: Municipalities and Champions - Example Istanbul'

Session 15 - October

Interactive Section

Title	Pop-Machina Academy Challenge Setup
Purpose	In this session the Maker Champions were asked to reflect on their local context and fill in the Challenge Setup Canvas based on that. The two previous sessions were already building up to this moment in which the participants basically just had to synthesize already existing content within one canvas. Additionally, they were asked to realistically review the current state of their CMS, which was limited due to COVID-19 19, and the opening of the CMS were in many cases postponed or yet to be defined. However, as the planning of the CMS had already begun, they were able to use the information they knew of, and to adapt accordingly. This session refers to the second step of the Co-Creation Journey "Framing the challenge".
Tools & Materials	Google Slides
Duration	1.5 hours
Output	Tangible starting point to execute the challenge
Learning Outcomes	The learning outcomes of these sessions can address all learning dimensions, depending on each Maker Champion and challenge chosen.

Table 31 'Pop-Machina Academy Interactive Session: Pop-Machina Academy Challenge Setup'

Session 16 - October

Interactive Section

Title	Pop-Machina Academy Challenge Setup 2
Purpose	During this session the Maker Champions received support to make their ideas for their local challenge tangible. They have received feedback for their ideas and the case of Leuven was used as an example. More information about the Leuven challenge follows in Figure 32.
Tools & Materials	Google Slides, Miro
Duration	1.5 hours
Output	Reflection on progress and support for the activities which address the challenge
Learning Outcomes	The learning outcomes of these sessions can address all learning dimensions, depending on each Maker Champion and challenge chosen.

Table 32 'Pop-Machina Academy Interactive Session: Pop-Machina Academy Challenge Setup 2'

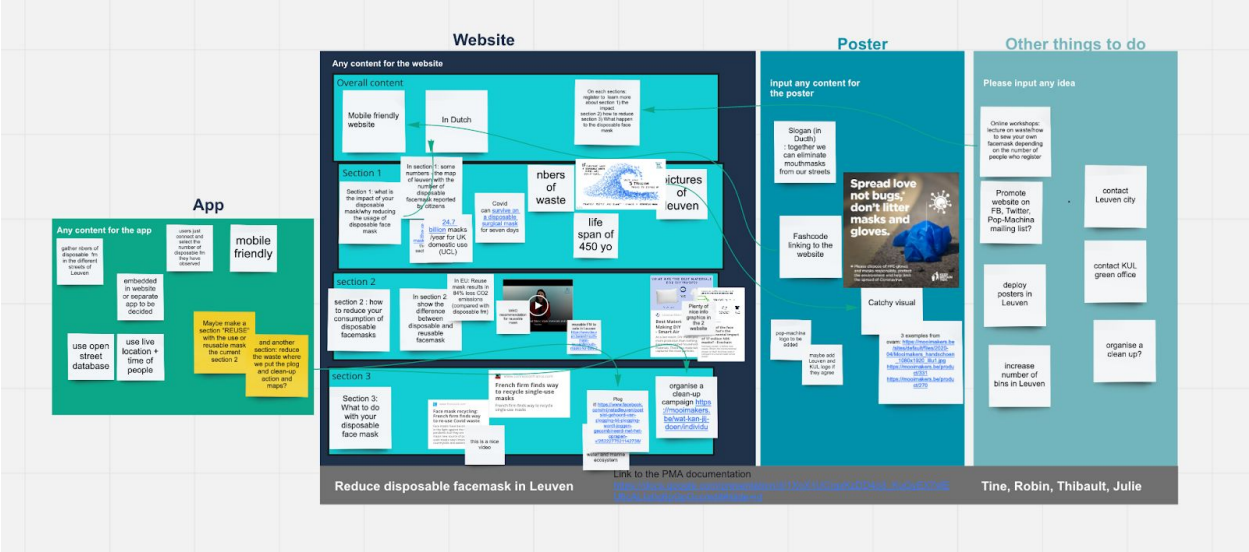


Figure 16 'Pop-Machina Academy October - Challenge Setup - Example Leuven'

The Maker Champion team in Leuven was exemplary. Immediately after session 15 they had a meeting together to brainstorm ideas. They were able to identify a local problem which was, in this case, single-use masks. Then they divided the work and contacted other city team members,such as the municipality, to synchronize their effort. Ultimately they have achieved a comprehensive campaign strategy and engaged with citizens through tangible actions. Their work was presented in a local online news platform. In general, the team in Leuven has proven to have very sufficient workflows; hence their CMS seems very promising.

Session 17 - October

Interactive Section

Title	Pop-Machina Academy Retrospective
Purpose	The final session of the Academy was dedicated to reflection and evaluation by the Circular Maker Champions community. They were asked to give feedback based on the 'Starfish model' (An image and explanation of this can be seen after this table). Together with the Maker Champions, a collaborative plan for the sustainment of the community was brainstormed.
Tools & Materials	Google Slides, Miro
Duration	1.5 hours
Output	Feedback for the Pop-Machina Academy and a plan to meet monthly to sustain the community of Maker Champions in the future.
Learning Outcomes	The learning outcomes of these sessions can address all learning dimensions, with a focus on reflection and evaluation.

Table 33 'Pop-Machina Academy Interactive Session: Pop-Machina Academy Retrospective '

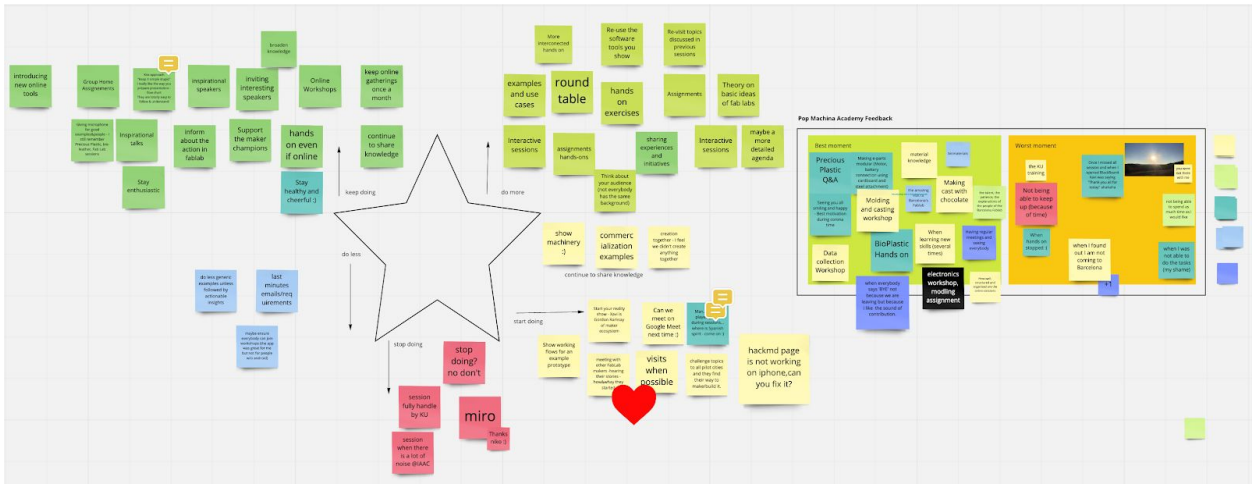


Figure 17 'Pop-Machina Academy Feedback'

The starfish evaluation is a simple method to collect feedback from participants in any kind of activity. There are five questions which are asked, positioned based on the shape of the star. This activity can be done online e.g. in Miro, as well as physically with pen, paper and post-its. The participants use the digital or physical post-its to fill the space with their answers. They are asked to be brutally honest – in that way only can the activity truly be improved for next iterations. The arrows facing upwards ask the participants which things should be 'done more' or which things they should 'keep on doing'. The downward-facing arrow asks what should be 'done less' or which things they should 'stop doing' and, lastly, the arrow facing to the right asks what they should be 'starting to do'. Next, the participants were asked to share their best and worst moments of the PMA. This was another crucial input for us, as facilitators to be able to evaluate the Academy.

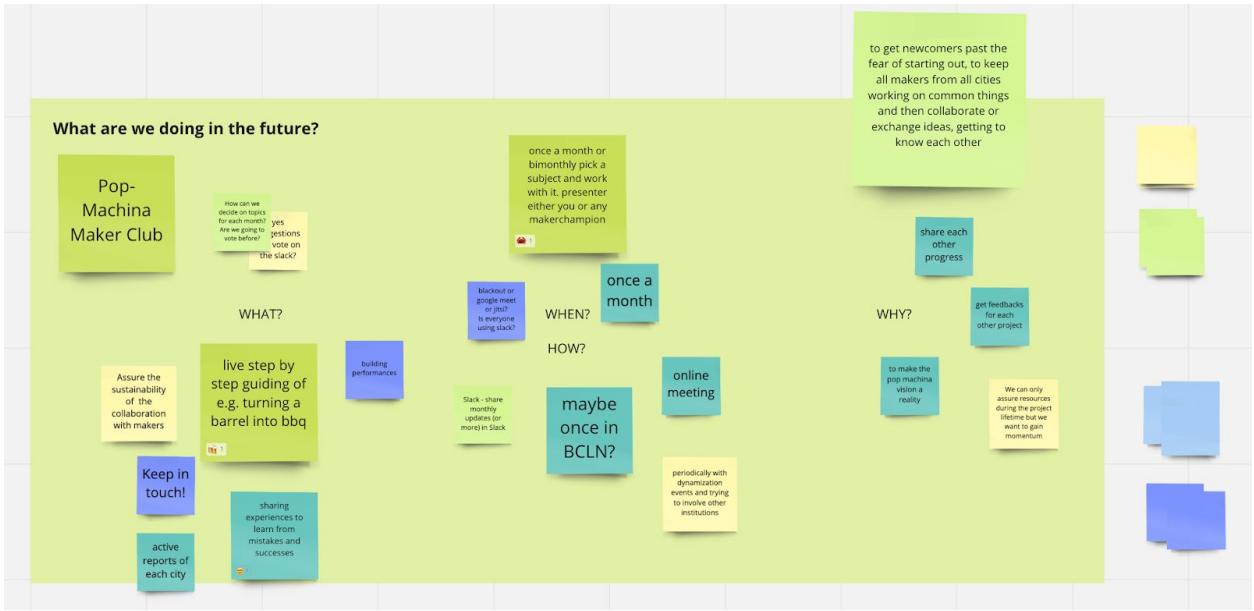


Figure 18 'Pop-Machina Academy Future of the Circular Maker Champion Community'

Lastly, a short ten-minute brainstorming session was initiated to collaboratively decide what should happen next for the PMA participants. It was clear that after all of these months the people attending the PMA truly became a community of Circular Maker Champions. Each one of the participants clearly stated that there was a need to keep this community alive. The decision was made to set up monthly meetings, starting either in December 2020 or January 2021, after the holiday season. In these monthly meetings the Maker Champions can come together as peers, update each other on the current status of their CMS, share insights and knowledge,

and simply sustain the community. These moments can be used for feedback, onboard new members, or similar. In conclusion, the governance and responsibility of these sessions is equally divided between all MCs. We as the team from Fab Lab Barcelona/ IAAC are there as peers and not as facilitators. And, with this, the autonomous phase starts.

Appendix 3 Circular Maker Space and Pilot Cities

1.0 Istanbul

Istanbul	Turkey
Area	2,676.85 km^2
Population	15,214,177
Makerspace Name	Makerspace Istanbul (There has not been a name defined yet)

Table 01 'Pilot City Istanbul'

What are the goals of the Makerspace in Istanbul?

The Istanbul Maker Champion team consists of eight people. Their goal is to foster communication and collaboration between the CMS, MCs and Pilot City. Furthermore, they are willing to encourage the cross-pollination between all Pilot Cities to share skills and exchange experiences. Defining concrete concepts, departments and documenting processes was an important topic for them. Istanbul is a big city with many local actors and an existing maker ecosystem. However, this network is not necessarily strong due to the size of the city and lack of communication between the actors. Hence the connection between the stakeholders, maker ecosystems, actors and hubs was a main goal for the Istanbul team. With achievement of the above goal, a strong network will enable ideas and collaborative projects to thrive.

At the start of 2020 the Istanbul team decided their preliminary city priorities together with WP5. The priorities were revised in city teams in the collaborative session 14. Istanbul, as seen in the figure below, focuses on five priorities (1) Raising awareness of general public and decision makers on sustainability and Circular Economy, (2) Understanding legislation for alternative businesses, (3) Technical training for Circular Making, (4) Enabling communication and collaboration among maker communities, municipalities, companies and CSO's and (5) Creating available and accessible venues where makers can sell/ barter their fabrications. Priorities (1), (3), (4) and (5) can be directly addressed in the CMS in Istanbul. The implementation of this is left to the city team and the pilot deployment planning.

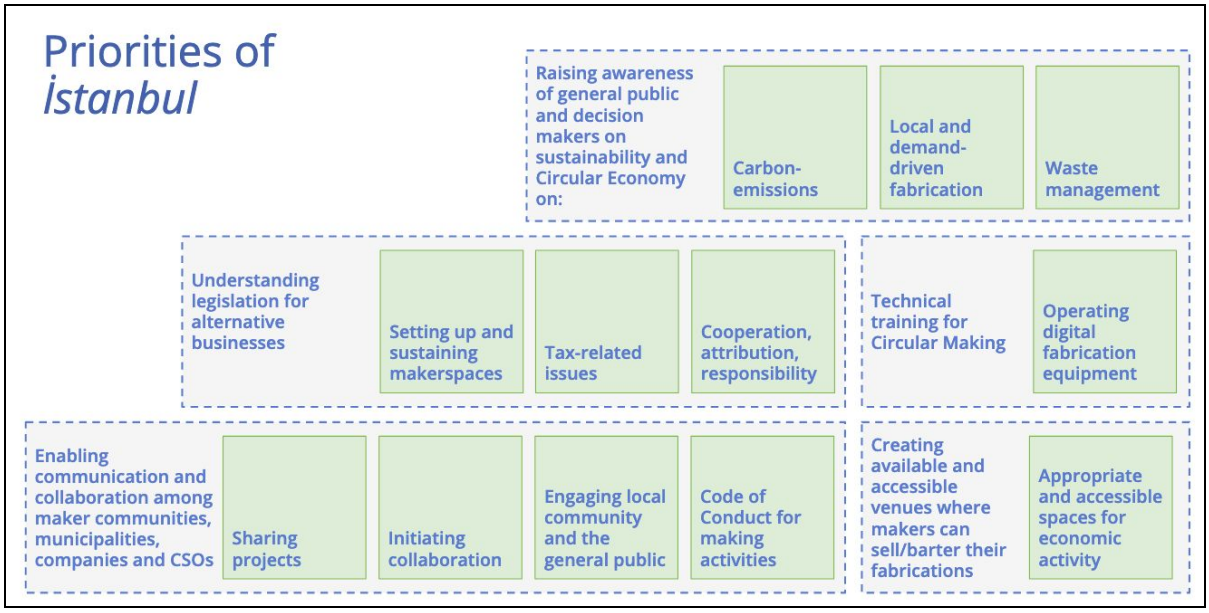


Figure 01 'Collaborative session with WP5: City Priorities Istanbul'

How will they engage citizens in circular maker communities?

During the collaborative session 14 with WP5 the Istanbul team collectively gathered key priorities on how to enable participation in community building Their six key priorities were (1) Igniting local communities, (2) Getting in touch with civil society, (3) Listing needs and necessities for the built environment, (4) Having yearly/periodical plans in advance, (5) Initiating participatory sessions with the communities and (6) Establishing a neighborhood/region-oriented action plan scoping circular activities. All of the above mentioned actions are aligned with the Pop-Machina approach. Furthermore, the group reflected on principles to be applied for successful implementation of community engagement. Due to Istanbul's size, the MCs expressed the importance of connecting existing maker hubs. Based on the profiles and interests of the MCs, and matching these with the city priorities, the team decided on 12 workshops to conduct in their CMS. The workshops mainly cover bio-materials, plastics,refurbishment and reuse of electronics and other materials for new purposes and strategic topics such as "how to align a makerspace with SDG's". The activities are adapted to be online as well as offline.

Conclusion

Istanbul has eight MCs. Throughout the duration of the PMA a strong bond was created between the MCs, especially after being able to meet physically. The Istanbul Maker Champion team has diverse backgrounds. This can be beneficial for the set up of the makerspace. Having a local team, with different backgrounds and expertise can contribute to a holistic approach for the CMS. Furthermore, work can be divided to offer diverse activities based on the expertise of the MCs. Lastly, the Istanbul City team (including municipality members, Pop-Machina representatives and MCs) have already proved good communication and collaboration. Their principles and ideas for the future of the CMS and pilot are inspiring.

Istanbul Maker Champions

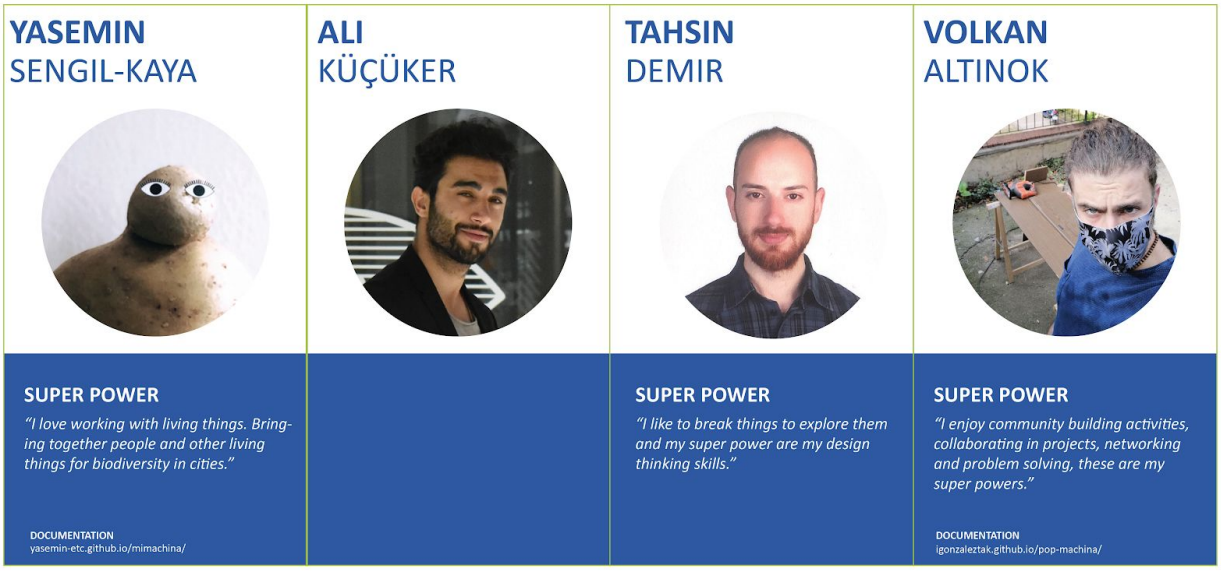


Figure 02 'Maker Champions Istanbul 1'

Figure 03 'Maker Champions Istanbul 2'

Istanbul Challenge setup

Figure 04 'Istanbul Challenge Setup'

2.0 Kaunas

Kaunas	Lithuania
Area	157 km^2
Population	328,763
Makerspace Name	Makerspace Kaunas (There has not been a name defined yet)

Table 02 - Table 36 'Pilot City Kaunas'

What are the goals of the makerspace in Kaunas?

Kaunas City has an active maker ecosystem with different actors engaged in it. The municipality is planning to incorporate the makerspace within the same building. The makerspace will offer space for co-working areas, experimentation and production. A complimentary area which is dedicated to workshops and events for citizens will be in close proximity. The location and what the space will offer will create the capacity for emerging projects. There will be a strong focus on the acceleration of projects, to enable people to make their ideas market ready. This idea is directly linked to the priorities of Kaunas. Kaunas preliminary city priorities from beginning of 2020 were revised in the collaborative session 14 with WP5. Kaunas, as seen in the figure below, focuses on four priorities (1) Initiate and sustain collaboration between the local government, civil society and SMEs, (2) Training for Circular Making, (3) Solutions through Circular Making and (4) Raising awareness of general public on sustainability and Circular Economy.

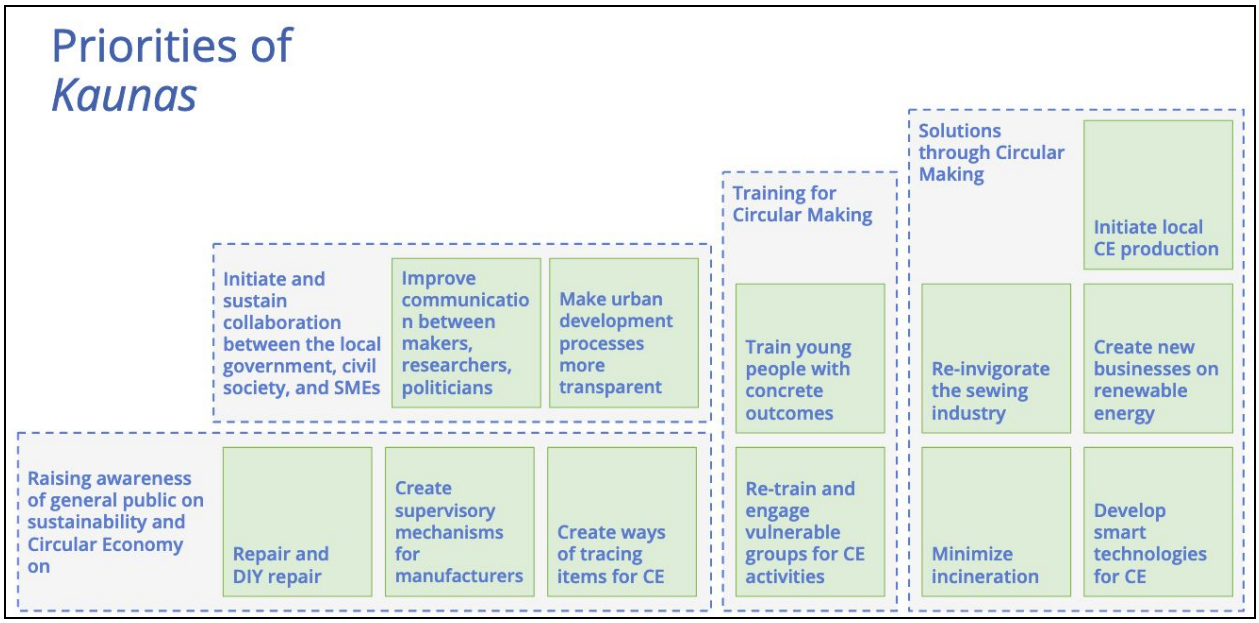


Figure 05 'Collaborative session with WP5: City Priorities Kaunas'

How will the makerspace in Kaunas engage citizens in circular maker communities?

The Kaunas City Team has come up with four priorities on how to engage citizens to become part of their circular maker community. First and foremost they would like to (1) work in cooperation with existing communities to grow the maker community, (2) Create an environment to work and brainstorm together to share knowledge and ideas which can help to elevate local initiatives. Furthermore, they would like to offer (3) Equipment and education on how to use it and (4) Professional knowledge support. The workshops which were chosen to address the city collaborative session with WP5 addressed not only the city priorities, but were also based on the personal interest of the Maker Champion and the existing interests of the local communities. They chose to concentrate on topics

such as: plastic recycling, electronics and programming, circular design and strategies for makers,and repair workshops for furniture and clothing. Almost all of the workshops will be held online as well as offline.

Conclusion

In conclusion, Kaunas would like to build on top of their existing local maker ecosystem and support the acceleration and sustainability of projects. Their point of view on what communities are, reflects well that the local team understands the different target groups. Communities, in their words, might be 'a gathering of people who share the same interests and are eager to create, teach and help each other. These communities might be connected geographically (citizens), in neighborhoods or in schools (students). But they can also be online, on platforms. Platforms which if accessible, can create a space to share information and connect people.'

Kaunas Maker Champion

Figure 06 'Maker Champion Kaunas'

Kaunas Challenge Setup

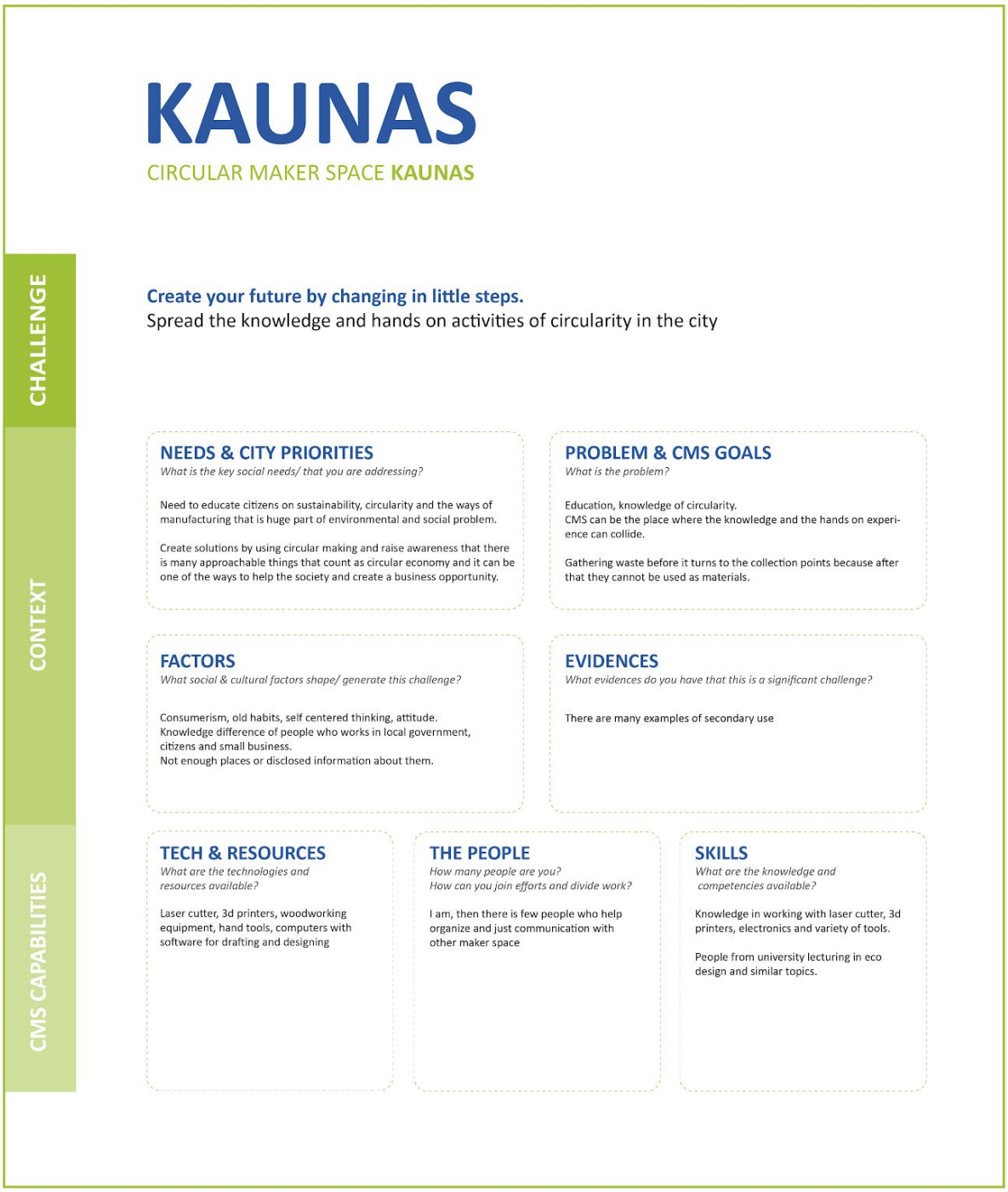


Figure 07 'Kaunas Challenge Setup'

3.0 Leuven

Leuven	Belgium
Area	56.63 km^2
Population	101,396
Makerspace Name	Maakleerplek

Table 03 - 'Pilot City Leuven'

What are the goals of Maakleerplek?

The team in Leuven wants to establish a space which reflects the local community while enabling innovation. Their proactive activities conducted simultaneously to the academy and previous to the start of pilot deployment activities has proven to be fruitful. The team has used Miro and other tools to enable their stakeholders to participate in the co-creation of Maakleerplek. The CMS in Leuven will build on top of an ecosystem of citizen initiatives. Together with the local existing maker organisation Maakbaar (an umbrella association which is already aware of, and involved in circular economy practices) they will establish a space called Maakleerplek. Maakleerplek will be located in Molens van Orshoven, a historic site of the city which is currently undergoing development. The space will host seven areas which all are dedicated to specific topics: the High-Tech Lab, Low-Tech Lab, New Media Lab, Steam-Studio, Co-working area, ateliers and a cantine. Additionally, Leuven initiated an online material bank in which citizens and makers can buy materials and contribute towards the stock. The materials in this online library are primarily considered excess, secondary raw materials or considered waste. However, there are many potential uses for these materials, especially, considering the enabling of multiple circular projects through this existing system.

In January 2020, Leuven decided their preliminary city priorities. Together with the Maker Champions and WP5 these priorities were revised during session 14. The analysis and correlation to the Pilot City deployment is being conducted in the framework of WP5. Nonetheless, the priorities of the city are taken into consideration for contextualizing challenges. Leuven, as seen in the figure below, focuses on five topics (1) Developing knowledge and embedding circular principles sustainable in policy, (2) Circular entrepreneurship, (3) Sustainable and circular consumption, (4) Repair, share and reuse and (5) Circular building. Most of these will not only influence the city deployment plan, but also the strategies and challenges set up in the CMS. In this case, especially in regard to sections (3) and (4).

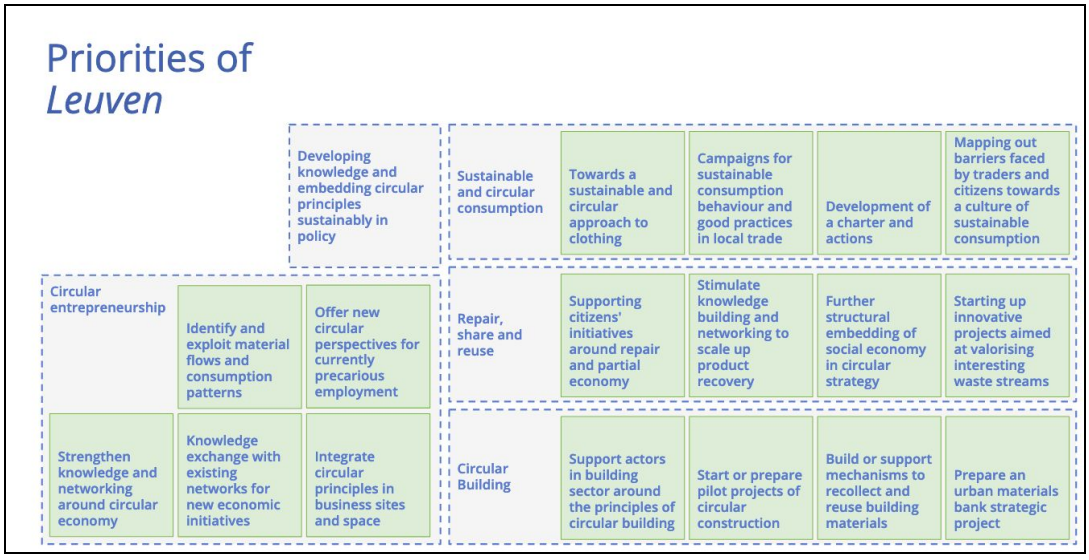


Figure 08 'Collaborative session with WP5: City Priorities Leuven'

How will Maakleerplek engage citizens in circular maker communities?

During session 4 each Maker Champion was asked to reflect how they/ the CMS could enable citizens to become part of a circular maker community. The Leuven team's answer to this was that through sharing the same ideas, people want to achieve the same goals. During the collaborative session 14 with WP5, the Leuven team further elaborated on this idea. Having the city priorities in mind, they have chosen to try to address all 21 workshops provided. Maakleerplek with their different areas of focus has an advantage in comparison to other already existing makerspaces. In contrast to existing spaces, they have the opportunity to co-create and reflect their citizen's interests in their space. Besides choosing the workshops they also have been asked to provide information if the activities are going to be online or offline, who will be the responsible person/ area and who will be the target group. 50% of their activities will be offline (on-site), 45% is planned to be both online and offline, and 5% is planned to be solely online. Their target audiences are very broad and range from children, to students and entrepreneurs.

Conclusion

The space with its different areas and their strong collaborative and co-design approach has so far proven its effectiveness. The strategy to involve different stakeholders in the process highlights that the space will have sufficient longevity after the Pop-Machina project lifecycle. By making the citizens and stakeholders part of the co-creation, the space automatically becomes part of the cities environment. Citizens are therefore more likely to connect a sense of responsibility and meaningness to the CMS. In general, the Leuven team has implemented the PMA principles with great sufficiency.

Leuvens Maker Champions

Figure 09 'Maker Champions Leuven'

Leuvens Challenge setup

Figure 10 'Leuven Challenge Setup'

4.0 Piraeus

Piraeus	Greece
Area	50.417 km^2
Population	448,997
Makerspace Name	Circular Maker Space Piraeus

Table 04 - 'Pilot City Piraeus'

What are the goals of the Circular Makerspace Piraeus?

Piraeus city is a port, hence their main activities are in close relation to marine topics. Many making practices can be linked towards their geolocation and historical connection to being a port which is directly connected to Athens. Unfortunately, this comes with the downside of marine, port and tourist-related pollution. As Pop-Machina has two city partners in Greece - Piraeus and Thessaloniki - they have decided to collaborate. Through one of the PMA sessions Thessaloniki and Piraeus contacted Anastasia Pistofidou, an employee from Fab Lab Barcelona (Her profile can be found in the annex 5 - The Pop-Machina Academy sessions). Anastasia's Work on the intersection of textiles and technology will guide, inspire and contribute to the goals of Thessaloniki and Piraeus. The preliminary city priorities were revised during the collaborative session 14 with WP5, where Piraeus will now focus on three main areas. They aim to (1) Invigorate Piraeus, (2) Initiate Circular Economy activities and (3) Work towards a Circular Blue Economy.

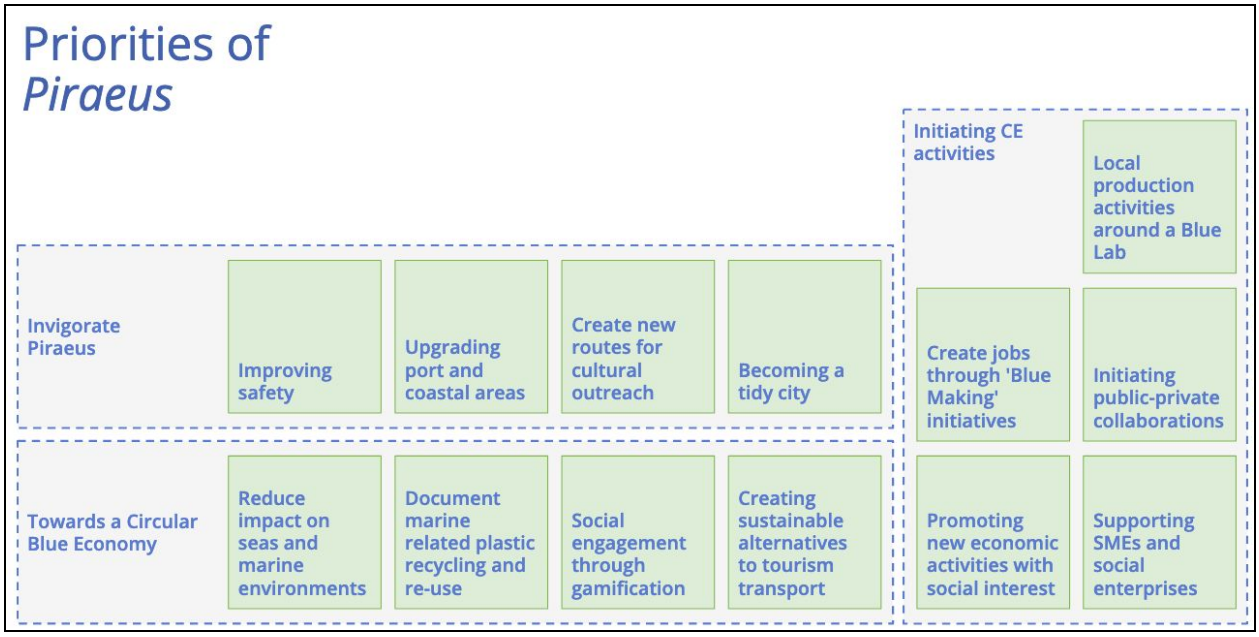


Figure 11 'Collaborative session with WP5: City Priorities Piraeus'

How will the Circular Maker Space Piraeus engage citizens in circular maker communities?

The Piraeus city team has identified three main steps to engage citizens in circular maker communities. Firstly, they want to catalogue: material availability, human resources,machinery, and innovative ideas which solve community issues. Secondly, they would like to identify local opportunities that engage stakeholders and policy makers in order to map needs and resources of their local ecosystem. Their aim is to understand possible relationships and dependencies between groups. The integration of top down environmental policies and bottom up local economies can create the opportunity for a holistic environment. The city team have chosen a variety of

workshops during the collaborative session with WP5 to match with their priorities. These range from: electronics experimentation through hardware,exploring data sensing and software-related topics. They will also engage with bioplastic and biowaste workshops.

Conclusion

Piraeus City, their CMS and Maker Champion have unique profiles due to their location, priorities and goals. Their action plan on engaging citizens offers a holistic approach for implementation. The pilots will shape workshops to address their main priorities. The workshops will act as a conversation starter with citizens to encourage engagement with the CMS.

Piraeus Maker Champion

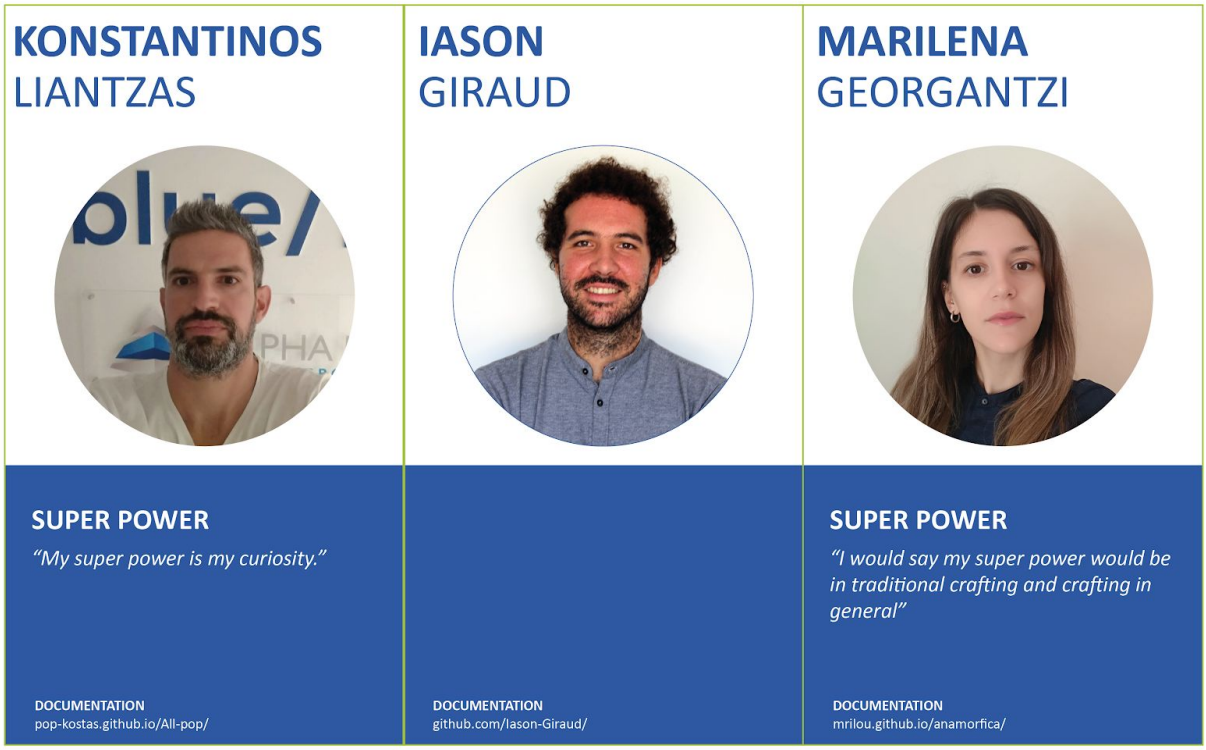


Figure 12 'Maker Champions Praeus'

Piraeus Challenge setup

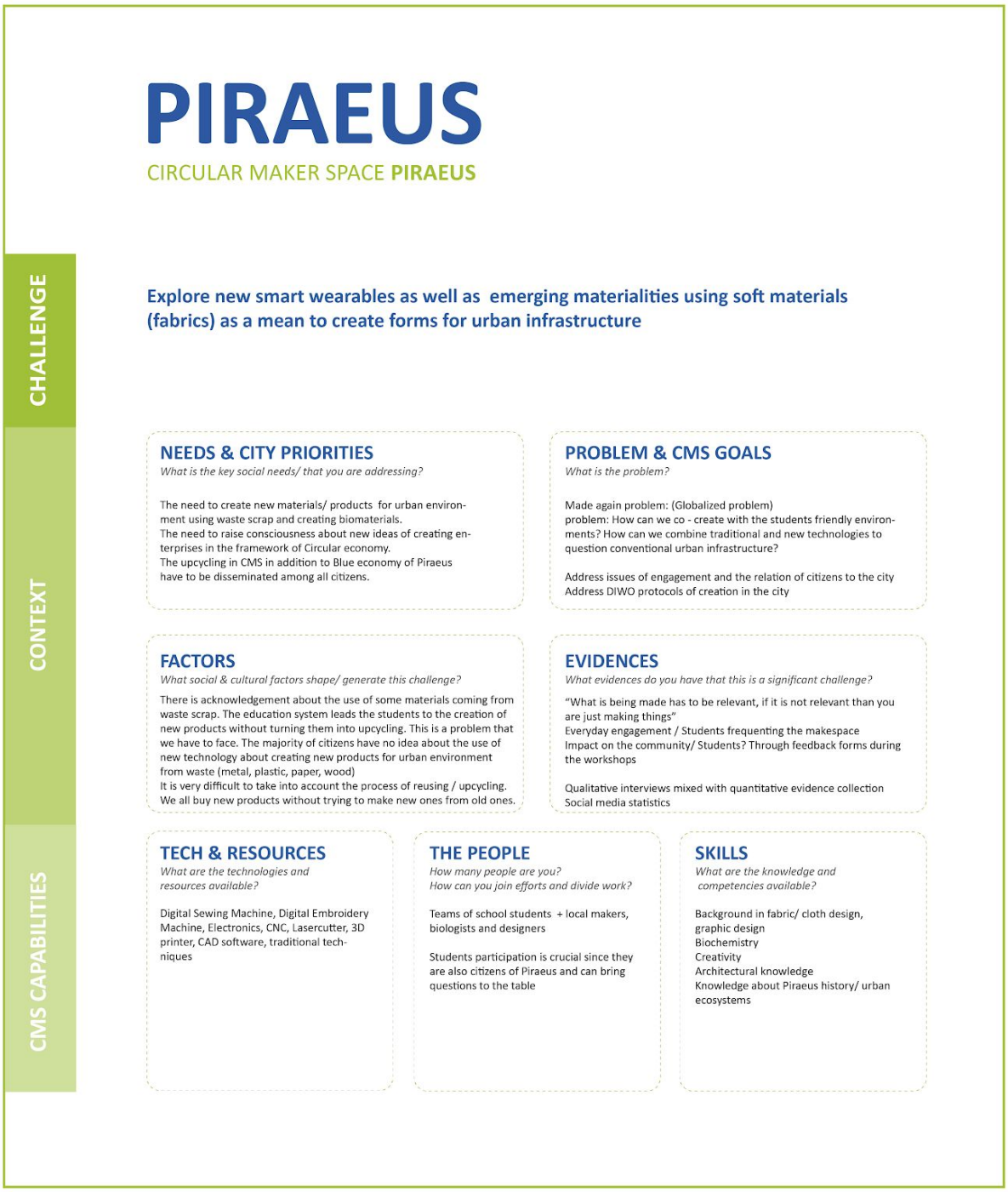


Figure 13 'Piraeus Challenge Setup'

5.0 Santander

Santander	Spain
Area	35 km^2
Population	172,044
Makerspace Name	Circular Maker Space Santander

Table 05 - 'Pilot City Santander'

What are the goals of the makerspace Santander?

Santander city and the municipality were in contact with us before the PMA started. We invited our Spanish colleagues to visit Fab Lab Barcelona at the start of the We hoped to inspire them and give practical insights on designing their CMS. Santander faces the challenge of many younger adults moving away to bigger cities. Therefore, one of their goals is to create an environment that inspires young adults to learn locally. This could foster project development and acceleration of businesses based on circular, innovative technologies.The CMS will be located close to the city centre, at the Mercado de México. The space will offer two main areas: one mixed workshop for general making activities (incl. electronics and mechanics), and one space dedicated for the set-up of Precious Plastic machines and recycling. Despite the spatial separation of the two areas,the collaboration and cross-pollination of ideas and projects will be encouraged. The makerspace in Santander will also host co-working areas for meetings and training. The priorities of Santander were revised during the collaborative session 14, in which they have mentioned that their focus will be on the (1) Communication of the value of "waste", they will (2) initiate and sustain Circular Making activities, (3) Reinvigorate the local economy, (4) Reverse the brain drain and(5) Legislative issues.

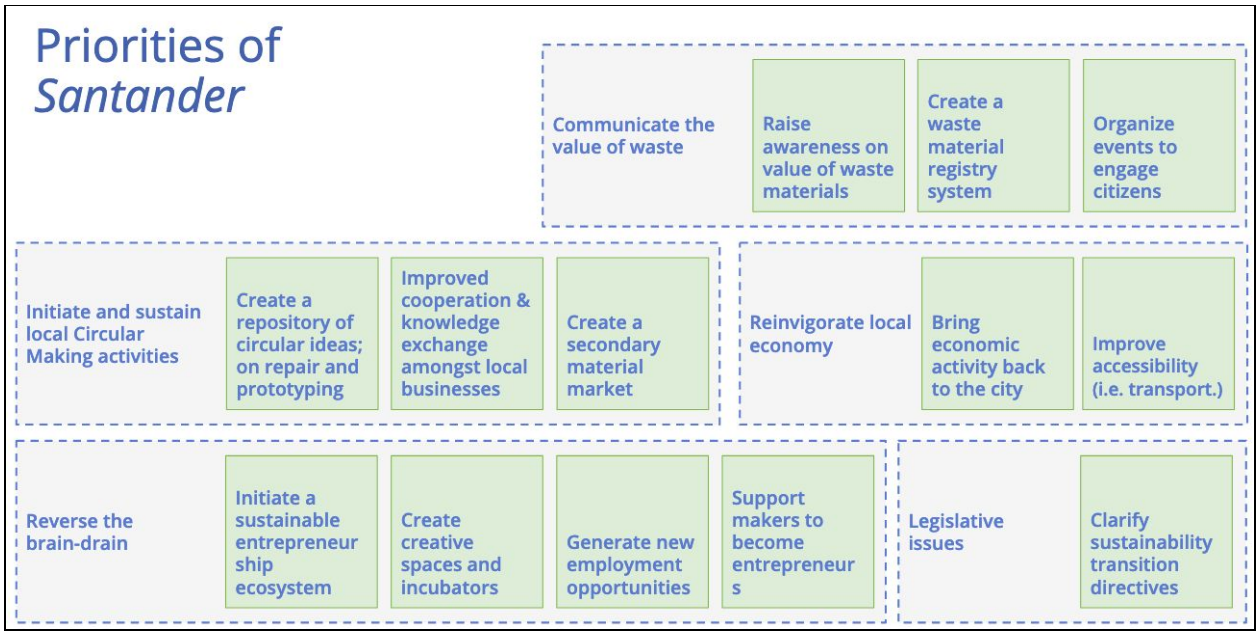


Figure 14 'Collaborative session with WP5: City Priorities Santander'

How will the makerspace of Santander engage citizens in circular maker communities?

The makerspace in Santander has many approaches to engaging citizens to become part of circular maker communities. For example, they would like to create a space to incentivise citizens. This could be in the form of challenges to develop projects and ideas.. They would like to create an environment that encourages learning about circular economy concepts to strengthen exchanges between stakeholders and citizens. This offers the potential to investigate different possibilities connected to existing material-flows. Their goal is to identify the key activities which will attract existing communities of practice, andl foster the development of communities around

a common interest. The workshops which Santander selected during the joint session with WP5 are about plastic recycling, plastic alternatives and circular design strategies. These activities are planned to be held online and offline. Activities which involve hands-on making will be held in the makerspace.

Conclusion

The makerspace in Santander has a strong focus on the recycling of plastics. They want to create a space in which people with different interests can come together, collaborate and cross-pollinate ideas. Existing communities around the Fab Lab Santander, could give the needed support for a fruitful development of the makerspace in Santander. Nevertheless it will be a challenge to inspire young adults to create businesses locally, rather than seeking for opportunities in larger cities. The makerspace in Santander could provide capacity building activities to which could inspire their path, whichever way it might lead. Development of business opportunities would lead to support for the local economy.

Santander Maker Champion

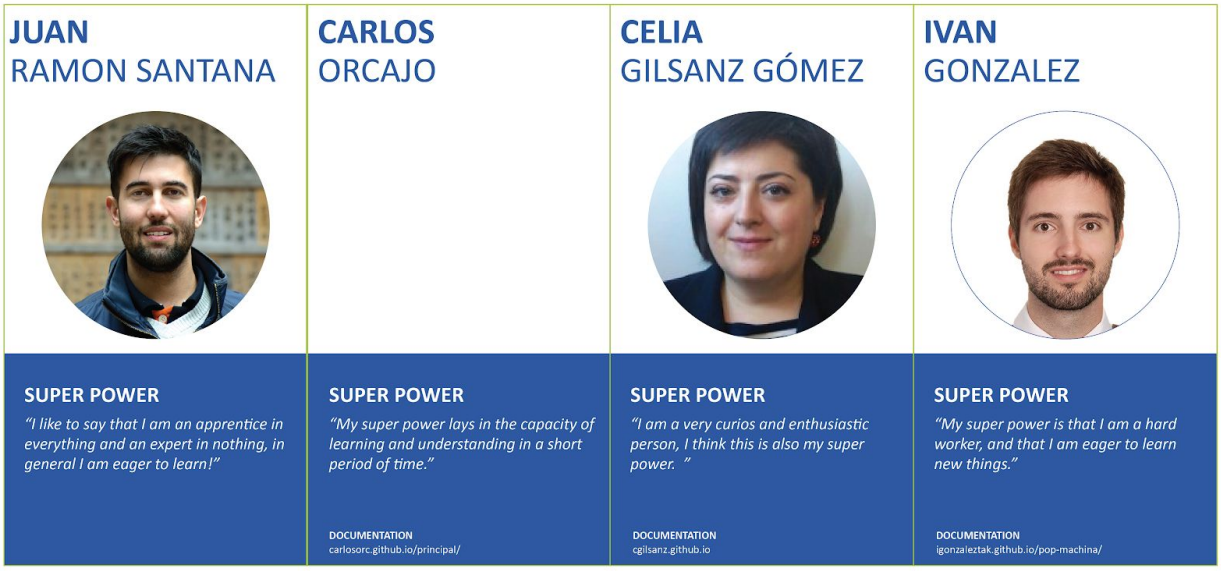


Figure 15 'Maker Champions Santander'

Santander Challenge Setup

Figure 16 'Santander Challenge Setup'

6.0 Thessaloniki

Thessaloniki	Greece
Area	1,285 km^2
Population	1,108,000
Makerspace Name	SKG Makers

Table 06 - 'Pilot City Thessaloniki'

What are the goals of the SKG Makers?

SKG Makers will be working in close contact with the start-up initiative OK!Thess. OK!Thess offers knowledge, coaching capabilities and the ability to accelerate projects emerging from the makerspace. The makerspace itself will hostspace to create new projects, prototype and serve as a location in which stakeholder, maker and municipality can come together to collaborate. The existing maker-ecosystem is well established in Thessaloniki. Effort will be put into connecting grassroot initiatives directly to the goals and priorities of the municipality. This could create a thriving environment and connect communities in and around the SKG Makers/ CMS in Thessaloniki. The makerspace will serve as a point of communication and intersection between different stakeholders. The revised city priorities of Thessaloniki are as follows (1) Reverse the brain-drain, (2) Green & sustainable development and (3) Invigorate public spaces in several neighborhoods.

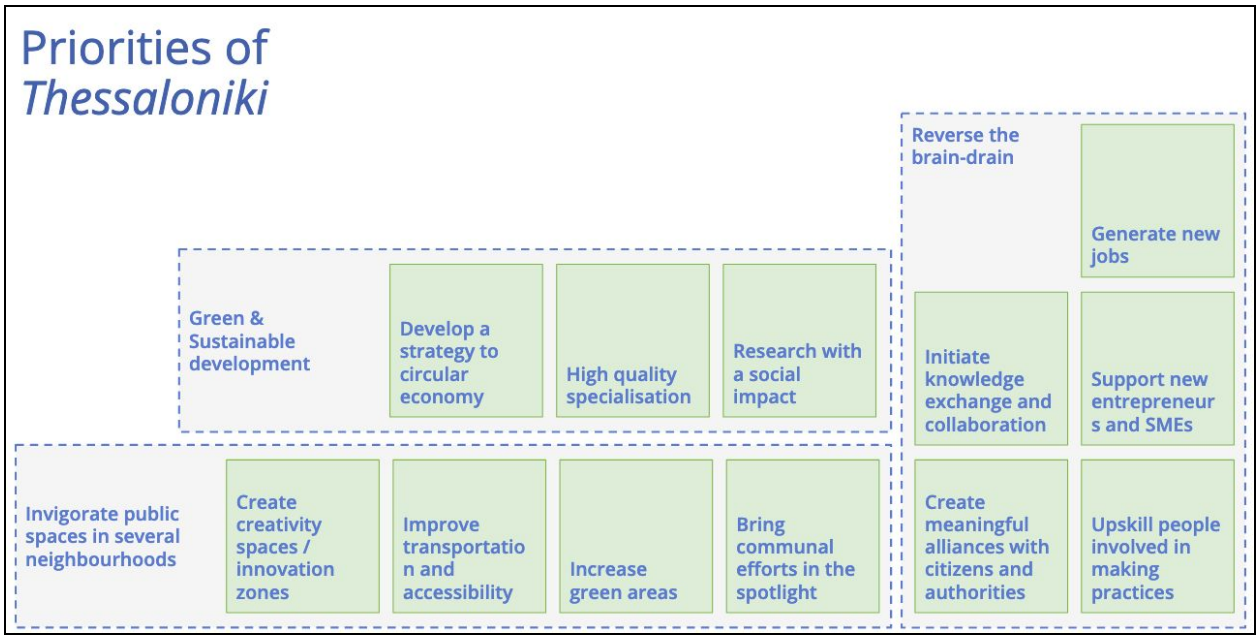


Figure 17 'Collaborative session with WP5: City Priorities Thessaloniki'

How will the SKG Makers engage citizens in circular maker communities?

The makerspace in Thessaloniki will provide the means to create and inspire to to try out new things. The Thessaloniki team believes that they can provide support to the maker's to improve their "soft-skills" and give the needed guidance to overcome obstacles. They will offer space to showcase their work and accelerate projects. This will be enabled through three cohorts in annual meetings with OK!Thess. Local communities and universities will come together in bi-monthly meetings at the SKG Maker Meet-up. Other maker

communities such as from Precious Plastic and Youthgreen will be welcomed at these sessions to engage and inspire the local makers. Furthermore, they would like to identify and drive forward local circular economy,disseminate the activities through the OK!Thess network,connect to radio stations and newspapers. They would like to contribute to a EU-wide collaboration between makerspaces. The initial steps towards this can be seen in the joint effort from the makerspaces in Piraeus and Thessaloniki. During the joint session 9 with WP5 the local team has chosen a variety of topics to address in their workshops, such as "Bioplastics", "Precious Plastics" and "Circular Design Strategies". They have chosen workshops such as "Circular Business Models" which other cities have opted not to do. The workshops will be held 50% online and 50% in the space.

Conclusion

SKG Makers together with OK!Thess will provide two spaces, with two different areas of expertise. Together these spaces will be able to compliment each other. In general we were able to see a strong engagement from the local team. They have already started activities with their local communities while the PMA was still ongoing. They have initiated activities such as the collection of "trash materials" and meet-ups. The early start of these activities, especially in regards to community establishment will be useful as soon as the makerspace will be inaugurated with the start of the pilot deployment. In conclusion, the team of Thessaloniki has a tangible action plan to create their CMS and foster community building activities.

Thessaloniki Maker Champions

Figure 18 'Maker Champion Christos Politis'

Thessaloniki Challenge Setup

Figure 19 'Thessaloniki Challenge Setup'

7.0 Venlo

Venlo	Netherlands
Area	128,99 km^2
Population	101,603
Makerspace Name	KanDoen

Table 07 - 'Pilot City Venlo'

What are the goals of the Circular Maker Space at KanDoen?

The makerspace in Venlo will be part of KanDoen. KanDoen is an organisation of the Municipality of Venlo. The aim of this space is to provide work for citizens with distance to the labour market. KanDoen offers a space for work, learning, exchange and collaboration. Together with the volunteers and employees, KanDoen offers small-scale manufacturing, artisan crafts and bicycle repair. The activities of Pop-Machina and the establishment of the CMS will expand the capabilities of this space. There are some improvements which can be done in terms of circularity. The activities conducted during the pilot deployment directly address this aim. Venlo was one of the first cities which aimed to apply the cradle to cradle philosophy. This offers a good opportunity and base understanding for a circular economy. However, there is still an existing gap between the citizens and stakeholders knowledge of circular economy and how to implement it in a tangible way. The priorities of Venlo city and the CMS in KanDoen are (1) Novel opportunities for circular production and value recapture, (2) Raise awareness on sustainability and circular economy, (3) Upskilling for transitioning towards circular economy and (4) New forms of collaboration.

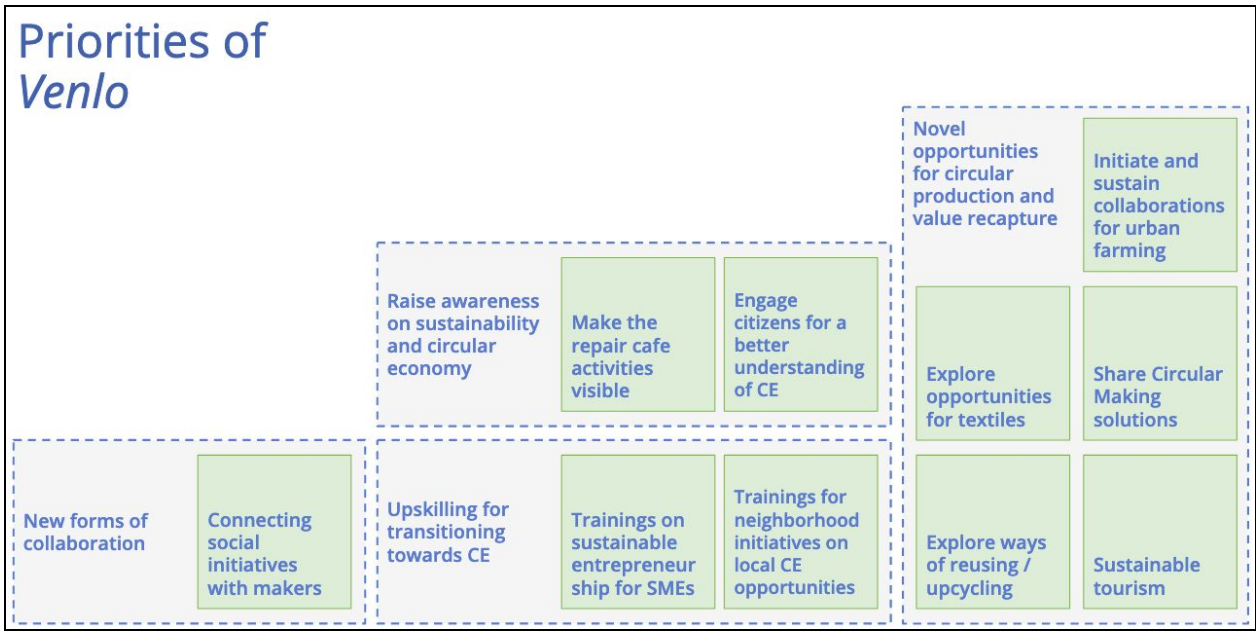


Figure 20 'Collaborative session with WP5: City Priorities Venlo'

How will KanDoen and the CMS engage citizens in circular maker communities?

KanDoen already has a rich portfolio of activities on how to engage their existing local communities. This portfolio will expand with the added "layer of circularity". Existing initiatives such as bike repair are already playing into this agenda. The workshops which will be conducted in the makerspace were decided during the collaborative session 9. Two workshops were identified based on the local

context. These two workshops are related to the existing bike repair activities and the interest in building vertical farms. Beyond these two the other workshops were chosen from the 21 workshop repository. Almost all workshops focus on low-tech capacity building.

Conclusion

KanDoen offers a unique opportunity and platform, especially for minority groups such as people with distance to the labour market. Their effort and existing initiatives are important for the local community. One example is the initiative together with the municipality - abandoned bicycles from the streets are collected and repaired at KanDoen. The bicycles are then distributed locally to families, in particular to youths to cycle to school. These families often cannot afford bicycles, also the usage of bicycles improves the health of the young people.

Venlo Maker Champion

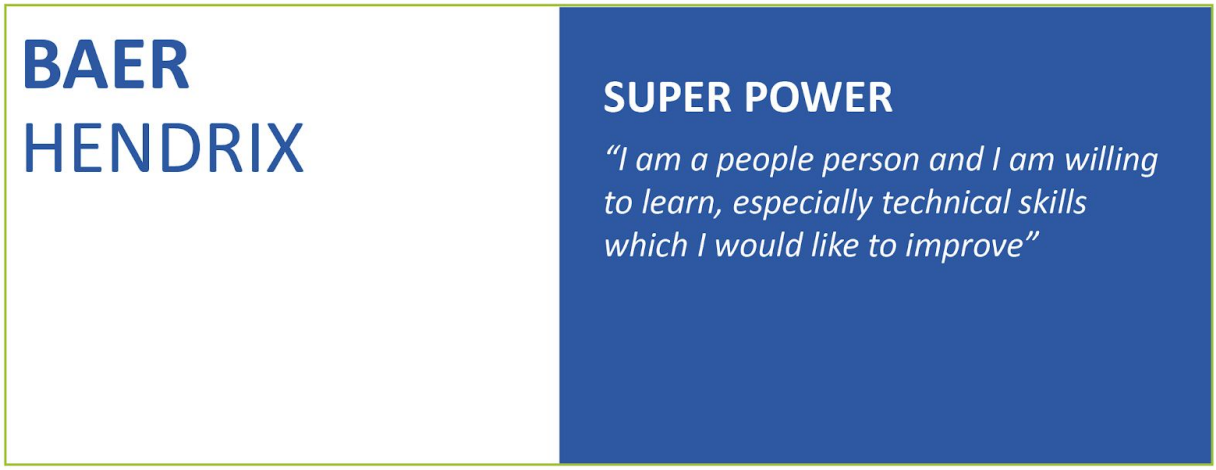


Figure 21 'Maker Champion Venlo'

Venlo Challenge Setup

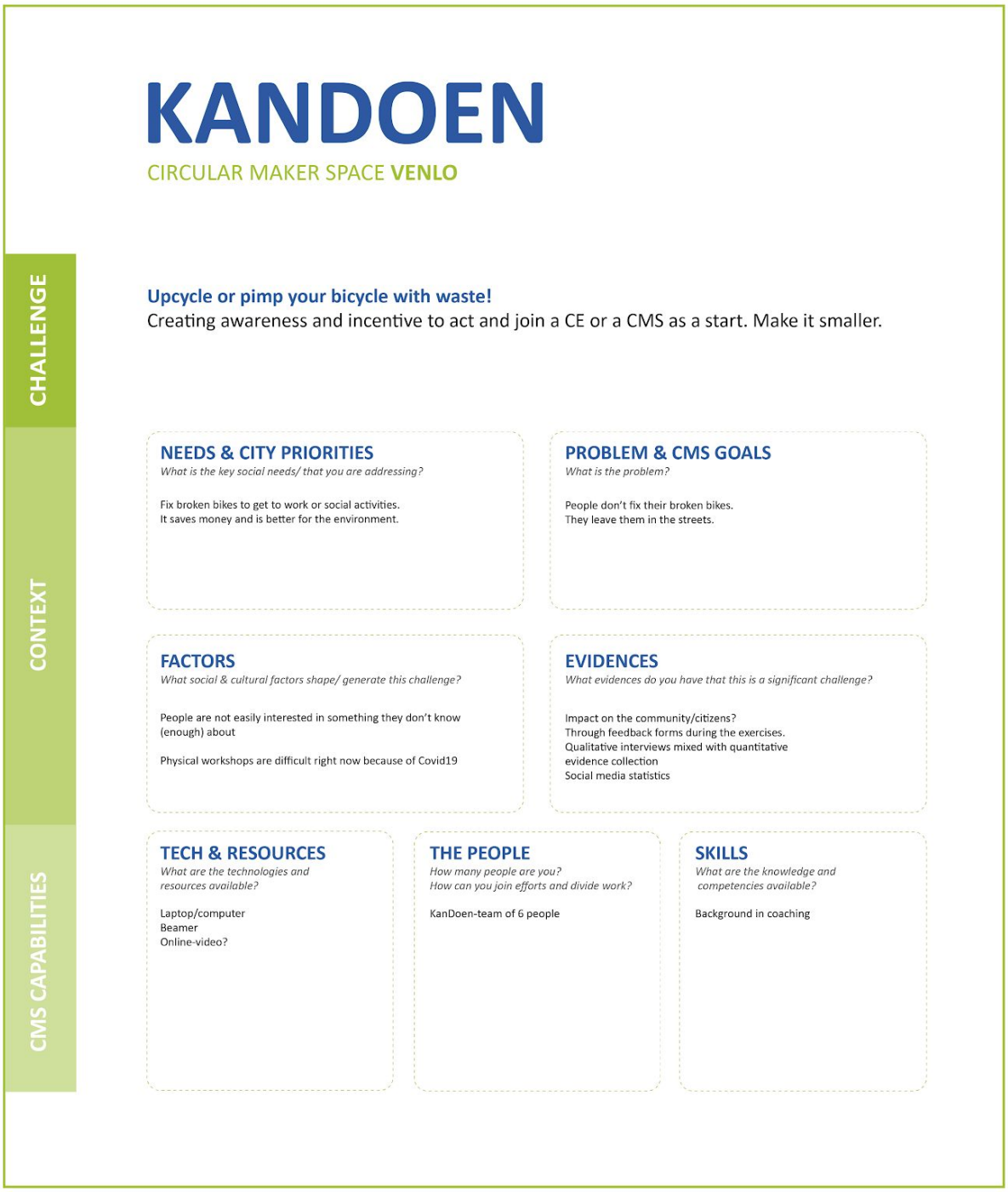


Figure 22 'Venlo Challenge Setup'